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A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1990.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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01 NATURE OF WATER

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02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

FLOOD HYDROCLIMATOLOGY.
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
For primary bibliographic entry see Field 2E.
W90-03663

HYDROLOGIC ASPECTS OF FLOODS IN EXTREME ARID ENVIRONMENTS.
Hebrew Univ., Jerusalem (Israel).
For primary bibliographic entry see Field 2E.
W90-03673

FLOODS IN COLD CLIMATES.
British Columbia Univ., Vancouver. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03674

CLIMATIC INFLUENCE ON UPPER MISSISSIPPI VALLEY FLOODS.
Wisconsin Univ.-Madison. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03678

HYDROCLIMATIC FLUCTUATIONS OF SOME EUROPEAN RIVERS SINCE 1800.
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
J. L. Probst.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 41-55. 5 fig, 5 tab, 41 ref.

Descriptors: *Geomorphology, *Europe, *Hydrologic cycle, *Climatology, *River systems, *Continental hydrology, Regional development, Precipitation, Evapotranspiration, Runoff, Discharge capacity, Catchment areas, Air circulation, Regression analysis, Rainfall distribution.

The three main components of the water cycle are precipitation (P), evapotranspiration (E), and runoff (R) which results in the difference between the two first components (R=P-E). River discharges may be considered as the runoff component of the water cycle in a natural system, represented by the drainage basin. Considering large rivers in Europe, the water cycle can be studied most appropriately at regional scale. River discharge depends on several factors but it may be viewed as an integral of the different hydroclimatic factors which have affected the drainage basin. The river discharge fluctuations in 14 different regions may be compared following latitudinal and longitudinal transects. The long-term discharge fluctuations of large rivers may be viewed as a regional barometer that allows the identification of the major hydroclimatic periods which have affected, on average, the river basins. In a small continental area, such as Europe, the river discharges fluctuate more or less synchronously over long time periods. The progressive lags of the hydroclimatic periods, going from west to east and from south to north, have not yet been completely elucidated, but may be related to the general atmospheric circulation and more particularly to the zonal and meridional propagation of the two-dimensional pressure anomaly pattern. European runoff fluctuations, reconstituted using regression analysis between river discharges, appear to be in phase with European rainfall patterns. (See also (W90-03689) (Fish-PTT)
W90-03692

HYDROLOGIC SYSTEMS. VOLUME I: RAINFALL-RUNOFF MODELING.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03764

ANNUAL REPORT OF THE NATIONAL BOARD OF WATERS AND THE ENVIRONMENT FOR 1988. (VESI-JA YMPARISTOHALLINTO, TOIMINTA KERTOMUS 1988).
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 6A.
W90-03817

EFFECTS OF CLIMATE CHANGE ON WATERSHED RUNOFF.
Geological Survey, Trenton, NJ. Water Resources Div.
D. M. Wolock, M. A. Ayers, L. E. Hay, and G. J. McCabe.
IN: Hydraulic Engineering '89 Proceedings, National Conference on Hydraulic Engineering, HY Div, ASCE, New Orleans, Louisiana, August 14-18, 1989. 1989. p 673-678, 1 tab, 11 ref.

Descriptors: *Watersheds, *Runoff, *Climatology, *Global warming, *Model studies, *Delaware River Basin, *Climates, *Hydrologic models, Carbon dioxide, Temperature, Precipitation, TOPMODEL, Stomatal resistance, Precipitation.

Forecasts of changes in watershed runoff in the Delaware River basin that result from a range of predicted effects of increased atmospheric carbon dioxide (CO_2) on future precipitation, temperature, and stomatal resistance of plants, were examined. A deterministic hydrologic model, TOPMODEL, was driven with stochastic inputs of temperature and precipitation to derive the forecasts. Results indicate that the direction and magnitude of the changes in watershed runoff are dependent on the relative magnitudes of the induced changes in precipitation, temperature, and stomatal resistance. Natural variability in temperature and precipitation obscured the changes in watershed runoff even when the simulated changes in precipitation, temperature, and stomatal resistance were substantial. (See also W90-03825) (Author's abstract)
W90-03824

GEOGRAPHIC INFORMATION SYSTEM/WATERSHED MODEL INTERFACE.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-03826

PHYSICALLY BASED NETWORK MODEL FOR TWO- AND THREE-PHASE SATURATION--CAPILLARY PRESSURE RELATIONSHIPS.
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 2G.
W90-03890

HYDROGEOLOGICAL AND HYDROGEOCHEMICAL CHARACTERIZATION AND IMPLICATIONS FOR CONSUMPTIVE GROUNDWATER USE OF A LARGE GLACIAL-DRIFT AQUIFER SYSTEM IN SOUTHWEST MICHIGAN.
Western Michigan Univ., Kalamazoo. Center for Water Research.
W. T. Straw, A. E. Kehew, Y. Darama, R. B. Wallace, and M. Kasenow.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-237283/AS, price codes: A06 in paper copy, A01 in microfiche. Michigan Institute of Water Research, East Lansing, Technical Report No. 88-G1569-03, April 1989. 114p, 14 fig, 8 tab, 11 ref, 2 append. USGS Contract no. 14-08-0001-G1569. USGS Project no. G1569-03.

Descriptors: *Model studies, *Michigan, *Geochemistry, *Geohydrology, *Groundwater, *Glacial aquifer, *Aquifer systems, *Consumptive use, Wetlands, Streamflow, Evapotranspiration, Recharge-discharge, Groundwater quality, Finite element model.

The Schoolcraft outwash fan, a thick deposit of sand and gravel extending eastward from the Kalamazoo Moraine in southwestern Michigan, contains a shallow unconfined aquifer impacted by irrigation withdrawals and both point and nonpoint source contamination. Groundwater flow and water quality in the aquifer was studied in the first year of this project with five clusters of nested piezometers and other individual wells. The stratigraphy of the aquifer was defined by drilling and gamma-ray logging. Water level measurements from nested piezometers indicate regional flow to the southeast with local perturbations caused by lakes and wetlands located in depressions in the surface topography. Water quality data from piezometers and domestic wells are being evaluated for use in determining recharge/discharge relationships and for defining horizontal and vertical zones of contamination with the aquifer. A steady state simulation of the regional groundwater flow system was developed to estimate the impacts of groundwater withdrawals on groundwater discharge to streams, wetlands and lakes in the aquifer. A 2-D finite element model was utilized to simulate the groundwater flow. The simulation model was calibrated to adjust the hydraulic conductivities and thickness. The calibrated model showed that aquifer piezometric heads and boundary fluxes to the stream were reasonable. The calibrated model also showed that the method for incorporating wetland ET requires improvement. Therefore, it was concluded that the numerical model should be modified to incorporate evapotranspiration as a function of the position of the water table. (USGS)
W90-03891

HYDROLOGIC INFORMATION AND ANALYSES REQUIRED FOR MITIGATING HYDROLOGIC EFFECTS OF URBANIZATION.
Washington Univ., Seattle. Dept. of Civil Engineering.
S. J. Burges, B. A. Stoker, M. S. Wigmosta, and R. A. Moeller.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109448/AS. Water Resources Series, Technical Report No. 117, June 1989. 131p, 54 fig, 7 tab, 132 ref, 8 append. USGS Contract no. 14-08-0001-G1300.

Descriptors: *Urban hydrology, *Hydrology, *Hydrographs, *Model studies, *Watersheds, *Hydrologic data, *Subsurface mapping, *Geographic information systems, Environmental impact, Urban planning, Rainfall, Runoff, Land use, Channels, Urbanization, Rainfall-runoff relationships.

The objectives were to characterize for gauged and ungauged catchments the pre-development hydrology and to determine or estimate the post-development hydrology and develop criteria for runoff control measures to mitigate hydrologic effects of development. Field observations combined with map and stereo aerial photograph interpretation are used to identify catchment features associated with runoff production. Hydrologic and geomorphic processes, that are identified by the process zone mapping procedure developed include areas of saturated overland flow, return flow, areas with significant water detention, and channel segments where sediment transport thresholds are likely to be exceeded. Process zone maps are prepared for any proposed development configuration and differences between them and the predevelop conditions are summarized. Changes in drainage density, water detention volume and quick storm response areas are associated with their respective downstream channels. Examination of the channel sections, bars, and substrate for channel segments draining relatively undisturbed and changed parts of the catchment, respectively, indicate critical channel erosion problems and erosion and deposition potential. Flow released from mitigative schemes, must be constrained above the start of first order-channels if channel geometry and stream habitat are to be preserved. The method yields primarily two-dimensional zone maps and channel segments, each having several associated attributes. The information is stored most conventionally using an appropriate geographic information system. A relatively simple spatially-distributed rainfall-runoff model for quantitative decision making was developed using the mapped extent of flow production zones as subareas within subcatchments. Upper soil (and litter) and lower soil depths

are included explicitly. The hydrographs determined for subareas (twenty to thirty/one hundred hectares) provide guidance for the type and location of appropriate mitigative measures to reduce hydrologic impacts. (USGS)
W90-03896

WATER TRANSFERS INTO GLACIAL DEPOSITS OF A WATERSHED IN THE GENEVA LAKE BASIN: WATER TRANSFERS IN THE UNSATURATED ZONE (ETUDE DES TRANSFERTS D'EAU A L'INTERIEUR D'UNE FORMATION MORAINIQUE DANS LE BASSIN DU LEMAN: TRANSFERTS D'EAU LA ZONE NON SATUREE).
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Centre de Recherches Geodynamiques.
For primary bibliographic entry see Field 2E.
W90-03912

MASSIVE WATER SCARCITY NOW THREATENING AFRICA--WHY ISN'T IT BEING ADDRESSED.
Swedish Natural Science Research Council, Stockholm.
For primary bibliographic entry see Field 6D.
W90-04004

RUNOFF MODELING UNDER NOISE-CORRUPTED RAINFALL CONDITIONS.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.
W90-04021

SIMULATING EFFECT OF CHANNEL CHANGES ON STREAM INFILTRATION.
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 2E.
W90-04122

FLOW PERSISTENCE AS A MODIFIER OF SEASONAL RUNOFF PATTERNS.
For primary bibliographic entry see Field 2E.
W90-04178

EVALUATION OF INFLOW TO MIRROR LAKE, NEW HAMPSHIRE.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2H.
W90-04203

GEOLOGY, HYDROLOGY AND HISTORY OF THE WASHINGTON, D.C. AREA.
American Geological Inst., Alexandria, VA.
1989. 114 p. Edited by John E. Moore, Julia A. Jackson, and Joan M. Rubin.

Descriptors: *Geohydrology, *History, *District of Columbia, Potomac River, Hydrology, Springs, Geology, Canals, Water supply, Channel improvement.

Washington, D.C., lies along the Potomac River and is about 130 miles (220 km) from the Atlantic Ocean. George Washington selected the site for the city in 1771, and the government moved here from Philadelphia in 1800. Pierre L'Enfant, who designed Washington, patterned it after Versailles, France. Today, Washington, D.C., has more than 600,000 inhabitants. If the surrounding suburbs are included, the metropolitan area has a total population of more than 3 million. This book contains articles that describe geologic, hydrologic, and historical features of Washington, D.C. In addition to the material of more strictly geologic and historical interest, sections are devoted to the Chesapeake and Ohio Canal, The Patowmack Canal, Potomac River Channel Improvements, and the District of Columbia Water Supply System. This book was prepared for participants of the 28th International Geological Congress. A walking tour allows the reader an opportunity to view features of topical interest and the architecture along Pennsylvania Avenue. (See also W90-04272) (Lantz-PTT)
W90-04271

IMPROVED HYDROLOGIC FORECASTING: WHY AND HOW.
Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. 452p.

Descriptors: *Hydrology, *Forecasting, *Water management, *Data interpretation, Economic aspects, Watershed management, Meteorology, Flood forecasting, Drought, Model studies, Streamflow, Flood plain management, Hydroelectric power.

This conference was structured to achieve several purposes. The primary purpose was to share lessons that were learned during the drought of 1976 and 1977 with practicing hydrologists. During that drought, methods that were developed during wet periods became unsatisfactory. Project forecasting for hydropower, for irrigation supply and for municipal and industrial supply came under more scrutiny than ever before. Another goal was to remind the practicing hydrologists of the wide variety of purposes for which the numbers he develops can be used. Too often the hydrologist sees only part of a project and does not recognize the full impact of his input; to raise a few thoughts about what the future may hold for the practicing hydrologist. Presentations are divided into eight broad categories: (1) analytic techniques in hydrology--state-of-the-art; (2) economic aspects of hydrologic forecasting; (3) meteorology and hydrology; (4) non-meteorological data; (5) power forecasting; (6) changing needs in hydrologic forecasting; (7) flooding and flood plain management; and (8) environmental applications. (See W90-04309 thru W90-04337) (Lantz-PTT)
W90-04308

2B. Precipitation

FLOOD CLIMATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03662

FLOOD HYDROCLIMATOLOGY.
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
For primary bibliographic entry see Field 2E.
W90-03663

WISCONSIN REGIONAL INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY (RILWAS): 1981-1983.
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
For primary bibliographic entry see Field 5B.
W90-03790

AUTOMATIC RAINFALL LOGGER AND SAMPLER FOR FIELD USE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 7B.
W90-03798

SIMULATION OF PRECIPITATION BY WEATHER-TYPE ANALYSIS.
Geological Survey, Trenton, NJ. Water Resources Div.
G. J. McCabe, L. E. Hay, L. S. Kalkstein, M. A. Ayers, and D. M. Wolock.
IN: Hydraulic Engineering '89 Proceedings, National Conference on Hydraulic Engineering, Hy Div, ASCE, New Orleans, Louisiana, August 14-18, 1989. 1989. p 679-684, 2 tab, 8 ref.

Descriptors: *Global warming, *Simulation analysis, *Precipitation, *Climates, *Weather forecasting, *Model studies, *Meteorology, *Philadelphia, Delaware River Basin, Stochastic analysis, Hydrologic models, Pennsylvania, Forecasting.

The US Geological Survey is studying the potential effects of climatic change on the water resources of the Delaware River basin. This task requires definition of regional climatic change, which is not provided by existing general circulation models. Therefore, a new approach that uses weather-type analysis as a basis for stochastic precipitation modeling was developed and tested for Philadelphia, PA. The weather types permit the identification of weather conditions associated with varying frequencies, intensities, and amounts of precipitation. Weather-type frequencies were used to simulate precipitation stochastically for Philadelphia to produce estimates that statistically match observed precipitation. A new method that applies climatic-change scenarios to weather-type frequencies to simulate future precipitation was developed. This weather-type procedure identifed weather conditions associated with varying frequencies, intensities, and amounts of precipitation, and provided a physical basis for developing stochastic models of precipitation. An analysis of precipitation distributions for each weather type indicated exponential distributions for all weather types. Assessment of the effects of potential climatic change requires weather-type calendars for future conditions. Analysis of the weather-type calendar for the 31-year period for Philadelphia provides probabilities of weather-type occurrence and persistence. (See also W90-03824) (Lantz-PTT)
W90-03825

SIMPLE MODEL OF DROPLET SPECTRAL EVOLUTION DURING TURBULENT MIXING.
Washington Univ., Seattle. Geophysics Program.
For primary bibliographic entry see Field 7C.
W90-03899

INTRASEASONAL PERIODICITIES IN INDIAN RAINFALL.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
D. L. Hartmann, and M. L. Michelsen.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 18, p 2828-2862, September 15, 1989. 23 fig, 1 tab, 38 ref.

Descriptors: *Climatology, *Meteorology, *India, *Rainfall, *Precipitation, *Monsoons, *Meteorological data collections, Statistical methods, Statistical analysis, Seasonal variation, Spectral analysis.

Spectral analysis of a 70-yr (1901-1970) record of daily precipitation from 3700 stations in India was carried out to search for periodicities on subseasonal time scales during the summer monsoon. Two statistically significant spectral peaks were found. A 40-50 day spectral peak corresponding the Madden-Julian Oscillation is found over most of the portion of India south of 23 degrees N. The phase of the oscillation is such that the precipitation maximum appears first over the relatively dry southeaster portion of the peninsula. Ten to 12 days later, the precipitation peaks simultaneously all along the coast west of the Western Ghats and along a line running across India between 20 degrees and 25 degrees N. The precipitation maximum then spreads slowly northward and loses significance. Cross-spectral analysis shoes strong coherence between the precipitation patterns and wind oscillations. In addition to the 40-50 day oscillation, significant spectral peaks and coherent structures in precipitation were found, whose characteristics correspond to those of monsoon lows. These are associated with a peak in the precipitation spectrum between about 5 and 7 days, which is strongest on the Bay of Bengal coast near 21 degrees N. The 5-7 day oscillation in precipitation extends west-northwest across the breadth of India along the known track of monsoon lows. The phase of the oscillation indicates that the precipitation anomalies propagate westward across India with a phase speed of about 5 m/s. This oscillation explains as much as 20% of the variance of precipitation in some locations. Evidence for a spectral

peak near 15 days is sparse, being limited to a few regions in the north of India where the 40-50 day oscillation does not dominate the low-frequency variance. (Author's abstract)
W90-03900

IN SITU MEASUREMENTS OF TOTAL REACTIVE NITROGEN, TOTAL WATER, AND AEROSOL IN A POLAR STRATOSPHERIC CLOUD IN THE ANTARCTIC.
National Oceanic and Atmospheric Administration, Boulder, CO. Aeronomy Lab.
D. W. Fahey, K. K. Kelly, G. V. Ferry, L. R. Poole, and J. C. Wilson.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol 94, No. 9, p 11,299-11,315, August 30 1989. 16 fig, 2 tab, 73 ref.

Descriptors: *Atmospheric water, *Clouds, *Water vapor, *Air pollution, *Aerosols, *Antarctica, *Water chemistry, *Water pollution effects, *Air pollution effects, *Ozone, *Nitrogen oxides, *Acid rain, Nitrogen, Nitrates, Chemistry of precipitation.

Measurements of total reactive nitrogen (NOy), total water, and aerosol were made as part of the Airborne Antarctic Ozone Experiment during August and September 1987. A polar stratospheric cloud (PSC) was encountered on a flight of the NASA ER-2 aircraft, containing concentration of 0.8-2.6 micron diameter aerosol particles greater than 1 cu cm. The temperatures in the cloud ranged as low as 184 K near 65 mb pressure, but they remained above the frost point of water ice, except for short intervals. From knowledge of the vapor pressures over nitric acid condensates, the appearance of aerosol above the background level is consistent with the formation of the trihydrate phase, HNO3-3H2O. The anisokinetic feature of the NOy sample probe enhances the concentration of large aerosol particles in the inlet by a factor of about 9. NOy levels above 20 ppb by volume observed in the PSC indicate that aerosol NOy species contribute substantially to the NOy signal. The amount of aerosol HNO3-3H2O necessary to enhance the NOy signal to observed levels is calculated from aerosol impaction theory and is found to be in satisfactory agreement with the observe aerosol volume. In addition, using the saturation vapor pressures and an estimate of available HNO3 in the cloud, the predicted volume of HNO3-3H2O) also shows satisfactory agreement with the directly measured aerosol volume. These results indicated that substantial aerosol volume containing HNO3 and H2O is formed at temperatures above the frost point in the Antarctic stratosphere in the winter and spring months. Such aerosol formation is thought to be the prerequisite for the production of active chlorine in heterogeneous reactions and for the large-scale removal of NOy through aerosol sedimentation. (Author's abstract)
W90-03901

PHYSICAL PROCESSES IN POLAR STRATOSPHERIC ICE CLOUDS.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
O. B. Toon, R. P. Jordan, J. Goodman, and G. Ferry.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol 94, No. 9, p 11,359-11,380, August 30 1989. 16 fig, 63 ref.

Descriptors: *Atmospheric water, *Model studies, *Atmospheric physics, *Nitrogen oxides, *Ice, *Clouds, *Water vapor, Acid rain, Aerosols, Atmosphere, Air circulation.

A one-dimensional model of cloud microphysics was used to simulate the formation and evolution of polar stratospheric ice clouds. The model results are in general agreement with many of the observed properties of these clouds, including their optical properties, impact on water vapor, and particle size. It was found that the clouds must undergo preferential nucleation upon the preexisting aerosols, just as tropospheric cirrus clouds do. Therefore, there is an energy barrier between stratospheric nitric acid particles and ice particles, implying that nitric acid does not form a continuous set of solutions between the trihydrate and ice. The Kelvin barrier is not significant in controlling the rate of formation of ice particles, except in air parcels that have cooled very slowly. It wa found that the cloud properties are very sensitive to the rate at which the air parcels cool. In wave clouds, with cooling rates of hundreds of degrees per day, most of the existing aerosols nucleate and become ice particles. Such clouds have particles with sizes of the order of a few microns, and optical depths of the order of unity, and are probably not efficient at removing materials from the stratosphere. Seasonal simulations showed that the lowest water vapor mixing ratio is determined by the lowest temperature reached and that the time when clouds disappear is controlled by the time when temperatures begin to rise above the minimum values. Hence, clouds occur in the early winter at temperatures that are higher than those at which clouds occur in the late winter. The ice clouds are not able to remove a significant amount of nitric acid through physical processes such as coagulation with, or nucleation upon, nitric acid aerosols. Such removal may occur through other processes, not included in the current simulations. (Author's abstract)
W90-03902

ESTIMATION OF RAINFALL IN BURKINA FASO USING THE ESOC PRECIPITATION INDEX.
European Space Operations Centre, Darmstadt (Germany, F.R.).
O. M. Turpeinen, and A. A. Diallo.
Journal of Climate JLCLEL, Vol. 2, No. 2, p 121-130, February 1989. 6 fig, 9 tab, 12 ref.

Descriptors: *Weather forecasting, *Burkina Faso, *Meteorology, *Rainfall, *Precipitation, *Seasonal variation, *Climatology, *Clouds, *Regression analysis, Weather, Weather data collections, Satellites, Remote sensing.

Rainfall is estimated in Burkina Faso for a full year using the ESOC precipitation index (EPI), a statistical cloud indexing method based on satellite data from METEOSAT. The EPI is converted into rainfall with the linear regression calculated between the EPI and the observed rainfall from a dense network of rain gages. Only one regression line based on the largest possible sample is used. THe accuracies of the yearly and seasonal rain estimates are assessed to determine whether a single EPI-rainfall relation can be applied. The results show that the yearly precipitation can be estimated to a high degree of accuracy. On the other hand, the precision of the seasonal estimates exhibits large fluctuations. While the dry season estimates are reliable, the transition between the dry and rainy season is characterized by a considerable overestimation, caused by the abundance of cold, nonprecipitating cirrus on the northern side of the intertropical convergence zone. During the rainy season, the method suffers from a slight underestimation. To resolve the major problem, that of nonprecipitating cirrus, a lower temperature threshold of 220 K instead of 235 K is applied in the determination of the EPI. The rain estimates for the transition period do improve slightly, but the gain is offset by the deterioration of the rain estimates made for the whole year and the rainy season. The results suggest that the rain estimates made with a single EPI-rainfall relation are useful, but that they could be improved with some type of seasonal adjustments. (Author's abstract)
W90-03914

MODES OF TROPICAL CIRCULATION, SOUTHERN OSCILLATION, AND SAHEL RAINFALL ANOMALIES.
Wisconsin Univ.-Madison. Dept. of Meteorology.
K. Wolter.
Journal of Climate JLCLEL, Vol. 2, No. 2, p 149-172, February 1989. 16 fig, 3 tab, 47 ref, append.
NSF Grant ATM-8722410 and NOAA Grant NA86 AAD-AC064.

Descriptors: *Southern oscillation, *Climatology, *Meteorology, *Weather, *Atmosphere, *Climates, *Africa, *Rainfall, *Drought, Seasonal variation, Air circulation, Statistical methods, Weather data collections, Clouds, Air-water interfaces.

The diagnostic understanding of large-scale climate variability in the tropics was investigated. The role and importance of the Southern Oscillation (SO) over the Atlantic, eastern Pacific, and Indian oceans was analyzed and compared with other surface circulation modes that contribute to interannual climate variations. Ship data, condensed into clusters of sea level pressure, surface wind, cloudiness, and sea surface temperature, were studied using orthogonally rotated principal component analysis. All four ocean-atmosphere elements were combined in the analysis. Five rotated principal components (PCs) appear as near optimal solutions in both boreal winter and summer. Most of these circulation modes feature a highly correlated, kindred mode in either the preceding or following extreme season, resulting in a preferred 2-year sequence of modes that starts with the boreal summer SO mode. An overall shift in the climate regime of the tropics is found at the end of the 1960s, heralding the recurrent climate extremes of the 1970s. The SO is confirmed as the most important circulation mode. In boreal summer, the second and third PC, called Atlantic Sahel and global Sahel mode, both correlate well with Subsaharan rainfall. The Atlantic Sahel mode focuses on the Atlantic near-equatorial trough, whose northward shift in conjunction with above-average North Atlantic SST has been associated previously with wet West African monsoon seasons. The global Sahel mode complements the Atlantic mode by emphasizing features in the Indian and South Atlantic Ocean domains, in particular, in the SST field which shows strong negative departures for abundant Sahel rainfall years, often preceded by a positively scoring SO mode in boreal winter (i.e., anomalously high/low pressure over the eastern/western Pacific). While the Atlantic Sahel mode relates better to the year-to-year variability of Subsaharan rainfall, the global Sahel mode features a strong negative trend that corresponds best to the long-term downward trend of this climate feature. Since both Sahel modes correlate strongly with precursor modes in boreal winter, some of the Sahel rainfall variance may be foreshadowed a semester in advance. (Author's abstract)
W90-03915

SEA SURFACE TEMPERATURES AND AUSTRALIAN WINTER RAINFALL.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
N. Nicholls.
Journal of Climate JLCLEL, Vol. 2, No. 9, p 965-973, September 1989. 8 fig, 23 ref.

Descriptors: *Southern oscillation, *Climatology, *Rainfall, *Precipitation, *Australia, *Climates, *Rainfall distribution, *Atmosphere, Weather, Weather data collections, Indian Ocean.

A rotated principal component analysis of Australian winter (June-August) rainfall revealed two large-scale patterns of variation which, together, accounted for more than half of the total rainfall variance. The first pattern was a broadband stretching from the northwest to the southeast corners of the country. The second was centered in the eastern third of the continent. The two patterns were correlated to sea surface temperatures in the Indian and Pacific oceans. The first rainfall pattern was best related to the difference in sea temperatures between the Indonesian region and the central Indian Ocean. The second rainfall pattern was related to equatorial Pacific sea surface temperatures. This relationship reflects the influence of the Southern Oscillation on both sea surface temperatures and Australian rainfall but the relationship between the first rainfall pattern and the difference between Indonesian and central Indian Ocean sea surface temperatures is largely independent of the Southern Oscillation. This sea surface temperature difference may be another factor influencing Australian rainfall, somewhat separate from the well-known effect of the Southern Oscillation. (Author's abstract)
W90-03916

TROPICAL SQUALL LINE OBSERVED DURING THE COPT 81 EXPERIMENT IN WEST AFRICA. PART II: WATER BUDGET.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
M. Chong, and D. Hauser.
Monthly Weather Review MWREAB, Vol. 117, No. 4, p 728-744, April 1989. 6 fig, 3 tab, 27 ref, 3 append.

Descriptors: *Meteorology, *Weather, *Storms, *Squalls, *Atmospheric water, *Air circulation, *Convective precipitation, *Hydrologic budget, Rainfall, Meteorological data collection, Remote sensing, Radar, Hydrologic cycle, Convection, Precipitation.

The relative contributions of the different processes involved in the water budget of the 22 June 1981 tropical squall line are investigated. The kinematic and thermodynamic fields derived from Doppler radar data are used to calculate the sources and sinks of condensate in the convective and trailing stratiform regions of the system. Both regions play an important role in providing the surface rain. Fifty-five to 65% of the total rain precipitated at the surface is convective, while the remaining 35-45%d is supplied by the trailing stratiform cloud. This partition corresponds to a precipitation efficiency of 47-45% for the convective region, and 45-57% for the stratiform region. Though these efficiencies are of the same order of magnitude, the sink of water substance in each region (before reaching the surface is attributable to different processes. In the convective region, loss of water substance is mainly due to the transfer of condensate into the trailing anvil cloud. This transfer represents 32% of the condensate formed in the convective updrafts and constitutes an important source (47%) of condensate for the stratiform cloud. In the stratiform region, the evaporation of precipitation that occurs beneath the trailing anvil cloud is predominant: 33% of the total condensate supplied to the cloud is lost in the mesoscale evaporative downdraft. Cooling effects due to this important evaporation, together with those associated with melting, help to maintain the observed mesoscale downdraft. Finally, this study indicates that the transfer of condensate from the convective to the stratiform region and mesoscale evaporation of precipitation may have a direct influence on the apparent feedback between convective-scale and mesoscale airflows. (Author's abstract)
W90-03921

PRECIPITATION LIFE CYCLE OF MESOSCALE CONVECTIVE COMPLEXES OVER THE CENTRAL UNITED STATES.
Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
R. L. McAnelly, and W. R. Cotton.
Monthly Weather Review MWREAB, Vol. 117, No. 4, p 784-808, April 1989. 18 fig, 2 tab, 45 ref.

Descriptors: *Meteorology, *Precipitation, *Convective precipitation, *Storms, *Weather, *Atmospheric water, *Clouds, Air circulation, Rainstorms, Satellites, Remote sensing, Rainfall, Atmosphere.

The mesoscale convective complex (MCC) is a common and particularly well-organized class of meso-alpha-scale storm systems over the central United States. As observed by infrared (IR) satellite, the typical MCC's 10-12 h evolution displays a fairly consistent sequence of events, including the monotonic areal expansion of its anvil from its formation to its maximum size, followed by the monotonic shrinkage of the colder cloud top areas as the system weakens and dissipates. Primarily within the growth phase of this cycle, a characteristic IR signature reflects the MCC in its most intense, mesoconvective stage, which lasts about 4 h and during which the coldest cloud top area reaches its largest extent. Hourly precipitation data were analyzed for 122 MCC cases that were selected from June-August 1977-83 and screened to insure a reasonable conformity with the typical IR life cycle. On average, these systems produced a rainfall volume of 3.46 cu km during their life cycle, over an area of 0.000032 sq km and at an average depth of 10.8 mm. Relative to a normalized, IR-defined life cycle, the averaged trends of hourly rainfall area, intensity, and volume all have well-defined growth/decay cycles, but with significantly staggered maxima. Average rainfall intensity (R), and the proportion of measurable reports due to convective intensities, attain maxima early in the life cycle. Hourly rainfall volumes (V) are more symmetrically distributed in time, with the maximum occurring ear the largest anvil size (based on minus 54 C IR threshold). Active rainfall area (A) continues to increase until about 1 h after the maximum anvil size. A statistical analysis of the studied precipitation characteristics provides an estimate of the natural interstorm variability for typical summertime MCCs. A comparison of various composite subsets of the sample reveals several tendencies: (1) smaller, less-organized systems tended to be 'drier' than similar-sized but better-organized MCCs; (2) large systems were 'rainier' than smaller ones in terms of A, V and R; (3) large systems tended to be 'rainier' in the eastern part of the sample domain than in the western part; and (4) the eastern systems, both large and small, had a more coherent and intense core of heavy precipitation through their life cycle than the western systems. (Author's abstract)
W90-03922

TROPOSPHERIC STATIC STABILITY AND CENTRAL NORTH AMERICAN GROWING SEASON RAINFALL.
Illinois State Water Survey Div., Champaign. Climatology and Meteorology Section.
R. A. Peppler, and P. J. Lamb.
Monthly Weather Review MWREAB, Vol. 117, No. 6, p 1156-1180, June 1989. 5 fig, 5 tab, 89 ref.

Descriptors: *Climatology, *Meteorology, *North America, *Rainfall, *Precipitation, *Rainfall distribution, *Atmospheric water, Condensation, Hydrologic cycle, Atmosphere, Weather, Weather data collections, Meteorological data collection, Great Plains.

The relation between tropospheric static stability and central North American growing season (May-August) rainfall for the highly contrasting years of 1975, 1976, and 1979, was investigated. Two extensive sets of meteorological data were used (individual rawinsonde soundings for 38 stations; hourly rainfall totals for 854-944 locations) for the region extending from the Rocky to the Appalachian Mountains and from the Gulf Coast to approximately 55 degrees N in Canada. The major objectives were to (1) ascertain which of the many available methods of parameterizing static stability are most strongly related to the above (predominantly convective) rainfall; and (2) quantify the rainfall variance fraction explained by static stability alone, as opposed to other atmospheric processes/conditions. Forty static stability indices and related thermodynamic parameters (SSITPs) were treated. The results pertaining to the first objective were definite and those concerning the second were encouraging. The SSITPs that correlate most strongly with rainfall amount consistently include the lifting condensation level (LCL) (near-region-wide) and the convective condensation level (CCL) (western U.S. Great Plains) for the afternoon half-day, and K-type and SWEAT indices (eastern U.S.) and the CCL and convective temperature (U.S.) Great Plains) for the morning half-day. In contrast, the SSITPs developed for forecasting severe thunderstorms and tornadoes correlate poorly with rainfall amount. Particularly high maximum afternoon SSITP-rainfall amount correlation magnitudes were obtained for the eastern U.S., far above those that earlier work yielded. (Author's abstract)
W90-03923

IMPACT ON WATER SUPPLIES.
H. E. Schwarz, and L. A. Dillard.
Oceanus OCEAAK, Vol. 32, No. 2, p 44-45, Summer 1989.

Descriptors: *Global warming, *Greenhouse effect, *Drinking water, *Potable water, *Water quality management, *Water management, *Economic aspects, Management planning, Sea level, Storm runoff, Municipal water, Water treatment, Water conveyance.

Senior managerial and technical people representing nine major urban water systems were interviewed to determine the impact of the greenhouse effect on drinking water and on the ability of water systems to deliver good, potable water. Among the conclusions drawn were that increased average precipitation, greater extremes of weather, and more frequent storms would cause problems in storm drainage. The effect of a sea level raise resulting from global warming would be increase salinity in water moving upstream in estuaries or bays, causing increased corrosion in pipes and pumping facilities. The cost of maintaining potable water at current safe standards would rise. The most significant finding from the interviews was the lack of acceptance of the likelihood and extent of climate change. Most professionals questioned took a 'wait and see' approach. (Friedmann-PTT)
W90-03924

OBSERVED AND MODELED TREND OF SULFATE AND NITRATE IN PRECIPITATION IN EASTERN NORTH AMERICA.
Massachusetts Inst. of Tech., Cambridge. Energy Lab.
For primary bibliographic entry see Field 5B.
W90-03935

KALMAN FILTER MODELING OF SPACE-TIME RAINFALL USING RADAR AND RAIN-GAUGE OBSERVATIONS.
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
K. Adamowski, and J. Muir.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 767-773, October 1989. 4 fig, 4 tab, 16 ref.

Descriptors: *Rainfall distribution, *Radar, *Rain gages, *Meteorology, *Depth-area-duration analysis, *Model testing, Algorithms, Data interpretation, Monitoring, Hydrologic models.

Conventional rain gage networks have proven to be inadequate to describe the temporal and spatial distribution of rainfall, but rain gage data combined with radar data can provide a very useful technique for monitoring the quantitative distribution of rainfall in time and space. A square grid mean areal rainfall model is developed, which utilizes rain gage measurements and a Kalman filter state-space model of the Z-R relationship from radar measurements. Results obtained showed good agreement between the square grid model and the state-space model for the three selected cells over a considerable part of the time interval considered. The model so developed can operate at spatial scales of the order of a river basin, can predict rainfall with at least several hours lead time, and is simple enough to operate in realtime and with reasonable computational needs. The developed method applies in areas where radar information exists, and it has been tested for one watershed. (Author's abstract)
W90-04024

CHARACTERISTICS OF EXTREME PRECIPITATION.
Ohio Univ., Athens. Dept. of Civil Engineering.
T. J. Chang.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1037-1040, October 1989. 1 tab, 9 ref.

Descriptors: *Model studies, *Meteorology, *Precipitation, *Rainfall, Excess rainfall, Correlation analysis, Discrete Autoregressive Moving Average Process, Discrete Autoregressive Model.

Records of extreme precipitation were investigated using the Discrete Autoregressive Moving Average (DARMA) process, which can explain the persistence of wet and dry spells that exist in daily precipitation data. The results show that the daily precipitation with strong autocorrelation is inclined to be better fit by a Discrete Autoregressive (DAR) model. On the other hand, those data with weak autocorrelations tend to be best fit by a Discrete Moving Average (DMA) model. It can also be concluded that based on the records from

extremely wet and dry regions there is no geographic preference regarding the selection of the best model. (Author's abstract)
W90-04208

APPLIED ATMOSPHERIC RESOURCES RESEARCH PROGRAM IN THAILAND.
Bureau of Reclamation, Denver, CO. Div. of Research and Lab. Services.
For primary bibliographic entry see Field 3B.
W90-04260

DETERMINATION OF DESIGN EVENTS FOR PRECIPITATION USING THE TIME-VARIABLE DATA RECORDING METHOD.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
H. Bergmann, and T. Zeyringer.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 317-327, 5 fig, 6 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Precipitation, *Data acquisition, *Design criteria, *Meteorological data collections, *Rainfall, Rain gages, Austria, Spatial distribution.

A new way of low-cost data recording for precipitation, providing high time resolution, has been developed. From running a dense network of gages in a small catchment area, it is possible to gather deeper insights into the fundamentals of time and space structure of rainfall on a small scale. The experimental basin in Poellau, Austria, provided data from seven gages over six years. The time resolution was one second, with a gage density of 8.3 sq km/station, which are stored on a data base. Several investigations both in time and space have been carried out. Parameters have been developed which were used for the determination of design events used as input for rainfall-runoff models. To account for the variability, the time and spatial distributions and dynamic parameters are used to calculate 'worse case' scenarios for the catchment area. (See also W90-04274) (Hammond-PTT)
W90-04299

MYTHS AND USES OF HYDROMETEOROLOGY IN FORECASTING.
Miami Univ., Oxford, OH. Inst. of Environmental Sciences.
For primary bibliographic entry see Field 6A.
W90-04316

HYDROCLIMATOLOGY--A NEEDED CROSS-DISCIPLINE.
International Engineering Co., Inc., San Francisco, CA.
R. F. Kilmartin.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 160-198, 3 fig, 105 ref.

Descriptors: *Climatology, *Hydrology, *Water resources management, *Forecasting, Irrigation programs, Long-term planning, History, Hydrometeorology, Stochastic analysis, Flood forecasting.

Major irrigation projects are planned for long time spans compared to most human endeavors, with 50-year planning periods not unusual. Climatic fluctuations within the planning period are customarily considered in design, but climatic trends pervading an entire planning period have not been generally considered. Although the direction and magnitude of future climatic changes over the next 50-100 years may not be certain, there is agreement that the climate of the past 3 generations has been quite abnormal compared to the last millenium as a whole. If the 1000-year norms are robust and the last 100 are an interial or random aberration, the consequences of projecting statistics from the latter period forward over the 50-year period ahead may be quite adverse. A new cross-discipline hydroclimatology, is suggested for developing quantitative techniques for considering the effects of long-term climatic fluctuations. The main tasks of project-oriented hydroclimatology would be: (1) to extend project streamflow records and other project-related climatic data as far back as possible, using original and extended precipitation data gotten through transfer function relationships with treering data or meteorological space time fields, with emphasis on preserving low-frequency events important in water resources design; (2) to investigate trends in all available local historic data and reconcile them with regional trends, correlations, and spectra; (3) to process local historic streamflow traces that are suitable for parameter estimation for use in stochastic modeling; and (4) to determine what non-random trend parameters (including zero) should be considered in the stochastic flow sequences for some or all of the planning period ahead. Statistical tools exist for accomplishing these analyses, however, there is evidently a need for improvement in methodologies for analysis of climatological space-time fields. The infrared signals are necessarily weak in short records, and Type I error statistical inference procedures frequently label them as white-noise manifestations when global teleconnections show they are not. (See also W90-04308)(Lantz-PTT)
W90-04319

PRECIPITATION FORECASTING AT A NATIONAL CENTER.
National Meteorological Center, Camp Springs, MD. Quantitative Precipitation Branch.
For primary bibliographic entry see Field 7C.
W90-04320

2C. Snow, Ice, and Frost

REGIME BED SLOPES OF CHANNELS WITH A BUOYANT BOUNDARY.
Windsor Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03643

CORRELATION OF SCANNING MULTICHANNEL MICROWAVE RADIOMETER (SMMR) OBSERVATIONS WITH SNOWPACK PROPERTIES OF THE UPPER COLORADO RIVER BASIN FOR WATER YEAR 1986.
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 7B.
W90-03823

INFILTRATION INTO A FROZEN HEAVY CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
For primary bibliographic entry see Field 2G.
W90-03984

TEST OF SNOWMELT-RUNOFF MODEL FOR A MAJOR RIVER BASIN IN WESTERN HIMALAYAS.
Howard Univ., Washington, DC. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2E.
W90-03985

UNRELIABILITY OF COLD-STORED SAMPLES FOR ASSESSMENT OF CHEMICAL PRECIPITATES OF PHOSPHATE IN ACTIVATED SLUDGE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-03995

SPECTRAL SIGNATURE OF ALPINE SNOW COVER FROM THE LANDSAT THEMATIC MAPPER.
California Univ., Santa Barbara. Dept. of Geography.
J. Dozier.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 9-22, April/June 1989. 5 fig, 4 tab, 44 ref, append.

Descriptors: *Mapping, *Remote sensing, *Satellite technology, *Snow, *Snow cover, *Landsat Thematic Mapper, Data interpretation, Model studies.

Mapping of snow and estimation of snow characteristics from satellite remote sensing data require that snow be distinguished from other surface cover and from clouds and that compensation is made for the effects of the atmosphere and rugged terrain. The spectral signature of the snowpack is calculated from a radiative transfer model, accounting for scattering and absorption by the ice grains, water inclusions, and particulates. In interpreting the spectral reflectance measured from the Thematic Mapper, or from any other satellite, it is necessary to account for topographic effects without requiring that satellite data be precisely registered to digital elevation data, because the poor quality of most digital elevation data introduces considerable noise into calculations of slope and azimuth. For a range of snow types, atmospheric profiles, and topographic illumination conditions, typical spectral signatures for the Landsat Thematic Mapper are estimated. TM images of the southern Sierra Nevada are analyzed to distinguish several classes of snow from other surface covers. Snow can be reliably distinguished from other surfaces and from clouds at all sun angles encountered in the mid-latitudes. In TM Band 1 or 2, snow is brighter than other natural surfaces, and in Band 5 clouds are usually much more reflective than snow. Large surface grain sizes can be distinguished from areas where the grain size is finer at the snow surface, using TM Bands 2, 4, and 5. Because of saturation in TM Band 1, estimation of the degree of contamination by absorbing aerosols is not feasible. (Author's abstract)
W90-04189

COMPARISON OF IN SITU AND LANDSAT DERIVED REFLECTANCE OF ALASKAN GLACIERS.
National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.
D. K. Hall, A. T. C. Chang, J. L. Foster, C. S. Benson, and W. M. Kovalick.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 23-31, April/June 1989. 2 fig, 1 tab, 34 ref.

Descriptors: *Climatology, *Remote sensing, *Satellite technology, *Alaska, *Glaciers, *Reflectance, Climates, Albedo, Atmospheric effects, Data processing, Mass balance.

Calculation of snow and ice albedo is necessary for developing physically realistic simulations of the Earth's climate using general circulation models, and useful for analysis of glacier mass balance change using remote sensing. Reflectances calculated from TM data and corrected for atmospheric effects correspond with in situ measured reflectances in the nadir-viewing mode, and are shown to be related to a glacier's mass balance if measured over a period of years. A reflectance of 0.895 for a test site in the Wrangell Mountains, Alaska, was calculated from TM Band 4 (0.76-0.90 microm) data and corrected for atmospheric effects. This value was comparable to the in situ reflectance of 0.90 measured in the same 0.76-0.90 microm wavelength region. For the same site, a reflectance value of 0.79 derived from integrating over most (0.40-3.0 microm) of the reflective portion of the electromagnetic spectrum was quite different from the integrated reflectance of 0.95 calculated for the spectral range 0.40-1.0 microm. This demonstrates the importance of using the full reflective energy spectrum for calculating the albedo of snow, and for obtaining a meaningful computation of a glacier's energy and mass balance change. (Author's abstract)
W90-04190

STAGE DISTRIBUTION APPROACH TO ESTIMATING ICE RELATED FLOODING PROBABILITIES.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. H. Burn.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 953-960, October 1989. 1 fig, 2 tab, 18 ref.

Descriptors: *Ice jams, *Flood forecasting, *Flood hazard, Ice-water interfaces, Yukon River, Data processing.

A procedure is presented for estimating flooding probabilities resulting from either open water or ice condition events. The methodology involves individually fitting a distribution function to water stages from open water and ice events and determining the composite probability of exceedence of any stage value. The parameters of the two distribution functions are estimated using censored maximum likelihood. This estimation procedure provides reasonably precise and accurate estimates of the stage resulting from open water and ice event flooding. The maximum likelihood technique is known to be an efficient parameter estimator, and it was expected that using censored maximum likelihood would result in accurate stage estimates. The approach was evaluated with a Monte Carlo sampling program and was applied to estimate flooding probabilities on the Yukon River. This application illustrated several points. The data and information required to utilize the advocated technique was demonstrated to be obtainable for a real world application which implies that the technique has general applicability. (Author's abstract)
W90-04199

2D. Evaporation and Transpiration

ECONOMIC ANALYSIS OF HARMFUL AND BENEFICIAL ASPECTS OF SALTCEDAR.
Great Western Research, Inc., Mesa, AZ.
For primary bibliographic entry see Field 3B.
W90-03818

GENERATION OF SYNTHETIC AND MISSING CLIMATIC DATA FOR PUERTO RICO.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
S. F. Shih, and K. S. Cheng.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 829-836, August 1989. 4 fig, 15 ref. USDA Dept. of Agriculture CBAG-23 project.

Descriptors: *Meteorology, *Model studies, *Climatology, *Puerto Rico, *Climatic data, *Evapotranspiration, Time series analysis, Data acquisition, Regression analysis, Historical trends.

Climatic data such as temperature, solar radiation, relative humidity, and wind speed have been widely used to estimate evapotranspiration. Most of the solar radiation data and portions of the relative humidity data are either not available or missing from the records in Puerto Rico. Depending upon the availability and data characteristics of records, three methods (including a regression technique, an average of historical data, and a regional average) were used to generate missing data and a time series analysis was used to synthesize a series of climatic data. The results showed that the time series analysis method can be successfully used to synthesize a series of monthly solar radiations for several stations. The regression technique and the regional average can be successfully applied to generate missing monthly solar radiation data. The regression technique and the averaging of historical data have been satisfactorily used to interpolate missing monthly relative humidity. The explained variance (R2) varied from 0.58 to 0.88, which are both significant at the 0.05 level of significance. (Author's abstract)
W90-04180

EARLY MORNING CANOPY TEMPERATURES FOR EVALUATING WATER STRESS IN A WHEAT CROP.
San Diego State Univ., CA. Dept. of Geography.
For primary bibliographic entry see Field 3F.
W90-04204

2E. Streamflow and Runoff

INTERNATIONAL CONFERENCE ON RIVER REGIME.
18-20 May 1988, Wallingford, England. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. Edited by Dr. W. R. White. 445p.

Descriptors: *Sediment transport, *Rivers, *Hydrological regime, *Regime streams, *River flow, *Streams, *Streamflow, *Streambeds, Model studies, Stream profiles, Streambeds, Stream erosion, River mechanics.

Major developments in the understanding of river regime which appear to be changing both the approach to the subject and its application were the focus of the international conference. Originally regime theory was entirely empirical and related the equilibrium dimensions and slope of the canals and sediment load. Subsequently, regime concepts were applied to natural rivers with their variable flows and sediment loads. The concept of a significant or 'dominant' discharge was introduced. One of the most radical advances in regime theory that has occurred recently has been the development of an analytical or rational approach. This new approach relies on a theoretical description of the dominant fluvial processes rather than on a purely empirical approach. The range of application of regime theory has been steadily increasing--from canals to sand bed streams and rivers and, more recently, to gravel bed rivers. The purpose of this conference is to exchange information and to develop and strengthen the contacts necessary for furthering the understanding of river regime. (See W90-03627 thru W90-03660) (White-Reimer-PTT)
W90-03626

DIMENSIONAL AND DIMENSIONLESS REGIME EQUATIONS FOR GRAVEL-BED RIVERS.
University of East Anglia, Norwich (England). School of Environmental Sciences.
R. D. Hey, and G. L. Heritage.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 1-8, 1 tab.

Descriptors: *Sediment transport, *Alluvial channels, *Bed load, *Channel morphology, *Stream profiles, *River mechanics, Gravel-bed streams, Model studies, Mathematical equations, Dimensional regime equations, Dimensionless regime equations, Comparison studies, Regime streams.

Several dimensional and dimensionless regime equations have been developed to predict the width, depth and slope of gravel-bed channels. However, differences between dimensional and dimensionless regime equations can cause problems regarding the choice of equation for practical engineering application. In order to address this problem, existing regime equations and those derived from published field data were reviewed to determine the nature and the reasons for differences between equations. Aggragated data was then used to derive general equations for engineering application. Comparisons between the two approaches for different data sets indicate that the coefficients and the exponents of discharge and bed material size in the equations are very sensitive to the values of the unmeasured controlling variables. In addition, the dimensionless equations are dependent on the form of the dimensionless groups used in the regression model. Given a well ordered data base, one in which the measurement error is minimal and which is defined by a unique set of physical equations, the two approaches give identical results. (See also W90-03626) (White-Reimer-PTT)
W90-03627

DOWNSTREAM HYDRAULIC GEOMETRY OF NONCOHESIVE ALLUVIAL CHANNELS.
Colorado State Univ., Fort Collins. Engineering Research Center.
P. Y. Julien.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 9-16, 1 fig, 14 ref.

Descriptors: *Channel morphology, *Sediment transport, *Alluvial channels, *Alluvial rivers, *Hydraulic geometry, Hydraulic models, Noncohesive alluvial channels, Mathematical equations, Flow resistance, Flow depth, Longitudinal mobility, Radial mobility.

Alluvial channels are known to self adjust their slope, width, depth, and velocity. After considering the similarities between noncohesive alluvial streams, the hydraulic geometry relationships for channel width, mean flow depth, mean flow velocity, and channel slope were theoretically derived. The following four fundamental concepts were considered: (1) continuity; (2) flow resistance; (3) longitudinal mobility; and (4) radial mobility. For flow depth the exponent of water discharge varies slightly around 0.4 and the exponent of sediment size can be either positive or negative depending on the relative roughness. Channel width is proportional to discharge and sediment transport and inversely proportional to sediment size. The average velocity is proportional to discharge, sediment size, and sediment mobility. The slope is proportional to sediment size and sediment mobility and inversely proportional to discharge. Therefore, the hydraulic geometry can be written as a power function of discharge, bed sediment size, and two mobility factors. For constant values of the mobility factors, the hydraulic geometry is then reduced to a power function of sediment size and discharge. (See also W90-03626) (White-Reimer-PTT)
W90-03628

DYNAMIC ADJUSTMENTS OF CHANNEL WIDTH AND SLOPE.
Bureau of Reclamation, Denver, CO.
C. T. Yang, and A. Molinas.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 17-28, 9 fig, 1 tab, 18 ref.

Descriptors: *Alluvial channels, *Sediment transport, *Channel morphology, *Stream profiles, *Streamflow, *River flow, Streambeds, Stream discharge, Width, Energy dissipation, Sediment load.

Rivers adjust their channel geometry and longitudinal profile in order to be compatible with the changing hydrologic, hydraulic, geological, and man-made constraints. Theoretical analyses based on the theory of minimum rate of energy dissipation were used to explain the impact of changing water discharge, channel width, and longitudinal profile on the rate of energy dissipation of an alluvial system. Using data from a natural river and stable canal to verify the theoretical analyses the following conclusions were reached: (1) The rate of energy dissipation of an alluvial system increases with increasing water discharge within a relatively short study reach; (2) For a given water discharge, the rate of energy dissipation decreases with increasing channel width; (3) The formation of pool-riffle sequences can increase the time-of-travel through a given reach and reduce the rate of energy dissipation; (4) At high flows or channel forming discharge, water discharge becomes a constraint in the minimization process; (5) The upstream and downstream boundary conditions or controls have to be clearly defined in the application of the theory of minimum rate of energy dissipation to obtain realistic channel width and profile; and (6) Sediment load is a constraint which should not be overlooked in the minimization process. (See also W90-03626) (White-Reimer-PTT)
W90-03629

PREDICTION OF HYDRAULIC GEOMETRY OF GRAVEL-BED STREAMS USING THE MINIMUM STREAM POWER CONCEPT.
Queen Mary Coll., London (England).
C. R. Thorne, H. H. Chang, and R. D. Hey.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon,

UK. 1988. p 29-40, 7 fig, 6 tab, 14 ref.

Descriptors: *Alluvial channels, *Channel morphology, *Sediment transport, *Hydraulic geometry, *Streambeds, *River beds, Gravel-bed streams, Minimum stream power concept, Velocity, Width, Water depth, Mathematical equations.

The hydraulic geometry of gravel-bed streams can be predicted using the minimum stream power concept. Application of the theory to data for British rivers shows that although the predictions are reasonable, considerable scatter exists. Width predictions are within 15% of measured values in about half of the cases and about two thirds of the cases for depth. Velocity is predicted to within 15% in half the cases. The analysis tends to systematically under-estimate width and over-estimate depth with increasing channel size. Channels with strongly vegetated banks tend to be narrower and deeper than predicted, while those with weak vegetation tend to be wider and shallower. Velocities in the channels with strong bank vegetation tend to be higher than in those with weakly vegetated banks because of the greater hydraulic efficiency of the narrower, deeper channels. The accuracy of predictions of hydraulic geometry can be markedly improved by adjusting the calculated widths and depths to account for bank vegetation effects. Adjusted widths were within 15% of measured values for 77% of the cases. The success rate for depth was 73% and for velocity 66%. It should be possible to incorporate the effects of bank vegetation into the analytical procedure by increasing the sophistication of the method of calculating the bank slope index. (See also W90-03626) (White-Reimer-PTT)
W90-03630

REGIME RELATIONS BASED ON DISPERSIVE-FORCE CONCENTRATION PROFILES.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
K. C. Wilson.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 41-54, 5 fig, 12 ref.

Descriptors: *Channel erosion, *Hydrological regime, *Sediment transport, *Channel scour, Bed load, Mathematical equations, Shear stress, Model studies, Suspended load.

Regime equations pertain to series of erodible channels of different sizes usually involving solids transport both as bed load and by turbulent suspension. These equations are based on power-law design relations for channel breadth and depth in terms of discharge, and can be considered as a method of representing each channel of the series as a vertically-distorted model of all the others. Equations of this type must be compatible with continuity conditions for both water and sediment, implying that each channel in the series has the same (time-averaged) delivered concentration of solids. If all of the solids are transported as bed load, it has been shown that 'traditional' regime equations can only be applied for a range of bed shear stress near twice the critical stress for the beginning of motion. In fact, the major application of the regime approach has been to channels in rather fine-grained alluvium, where solids transport involves a combination of bed-load motion and turbulent suspension. Analysis of this combination requires a link between suspended-load and bed-load profiles--to be sought in a small zone just above the stationary bed, where shear stress and solids concentration are often large, and observation is remarkably difficult. These aspects were analyzed using a new dispersive-force model in which the submerged weight of solid particles is balanced by a combination of intergranular normal stress and a dispersive force caused by fluid turbulence. The resulting profiles give delivered concentration, and for given solids the lines of constant concentration are approximated by power-law relations. Manipulation then produces 'derived' regime relations for any desired combination of particle size and concentration, which compare well with the usual 'field-based' equations. (Author's abstract)
W90-03631

REGIME CHANNELS OF AN EXTREMELY ARID ZONE.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
M. Nouh.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 55-66, 4 fig, 34 ref, append.

Descriptors: *Regime channels, *Arid-zone hydrology, *Saudi Arabia, *Flash floods, *Channel morphology, *Sediment transport, *Alluvial channels, *Ephemeral streams, Channel scour, Hydrographs, Model studies, Mathematical equations, Suspended sediments, Regression analysis.

Field observations were collected from 37 ephemeral channels of an extremely arid zone in Saudi Arabia, and used to develop regime formulae relating the channel dimensions and pattern to the characteristics of flash flood and sediment flow in the channels. Previous investigations indicated that in ephemeral channels of extremely arid areas the correlation of width, depth, and channel slope with average discharge is not suitable for studying the variation in downstream hydraulic characteristics. This is due to the high variability of discharge even from one hour to another during a flash flood event, and the large amount of suspended sediments that are carried by some (not all) streams during the floods. In order to describe the variation of water and sediment flow conditions in the area the following variables were selected: peak flowrate, mean flowrate, time to peak flowrate, and duration of hydrograph. In addition, different definitions for the peak flowrate and the mean flowrate of hydrograph in the study zone were investigated to best fit the regime equations. Through field sampling it was possible to identify the size distribution of the original sediments and that of the armoured layers and flash flood hydrographs for 50 cross sections. The data was divided into two groups; one for the regression analysis and the other for the verification analysis. A ratio of peak flood flowrate for a given return period to annual mean flood flowrate was developed to describe flow conditions in the channels. This ratio was used successfully in regression type formulae to predict the dimensions and pattern as well as the bed armouring characteristics of an ephemeral channel in an arid zone. (See also W90-03626) (White-Reimer-PTT)
W90-03632

APPLICATION OF REGIME THEORY TO WADI CHANNELS IN DESERT CONDITIONS.
Binnie and Partners, Redhill (England).
P. B. Clark, and S. M. A. Davies.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 67-82, 5 fig, 3 tab, 18 ref.

Descriptors: *Hydrological regime, *Yemen, *Ephemeral streams, *Alluvial channels, *Sediment transport, *Channel morphology, *Flow characteristics, Steep slopes, Mathematical equations, Discharge hydrographs.

In South Yemen slopes are extremely steep, channel sections cannot be considered stable and the ephemeral nature of flows and their infrequency raises problems as to the nature of any regime condition and even to the concept itself. In addition, the activities of man have had a significant effect on the channel section. Therefore, an attempt has been made to establish general hydraulic parameters for each reach in order to allow for the design of a future program for individual training and bank protection programs. The evidence suggests that Bray's regime relationship for channel width gives reasonable values when used with representative flows of greater rarity then are usually considered applicable. Such flows have been estimated to have return periods of between about 5 and 20 years and there is some indication that the return period is a function of the frequency of spate flows. Other available regime relationships relating depth of flow and slope to a representative flow appear not to be applicable for these very steep channels. Equations for the slope/discharge relationships have been developed from the data set but, particularly in view of the difficulty in defining the dominant discharge, these must be viewed as tentative. A relationship between the channel wavelength and dominant discharge has also been developed as this wavelength appears to be a measurable parameter that might provide an independent check on the dominant discharge for further work on this type of channel. (Author's abstract)
W90-03633

CAUSE OF RIVER MEANDERING.
San Diego State Univ., CA. Dept. of Civil Engineering.
H. H. Chang.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 83-93, 2 fig, 35 ref.

Descriptors: *Sediment transport, *Channel morphology, *Geomorphology, *Alluvial channels, *Rivers, *River mechanics, *Meanders, Fluvial processes, Slopes, Geohydrology, Valleys, Time span.

Previous theses on the cause of river meandering are reviewed and criticized on the basis whether the cause and effect are identified in interpreting the fluvial processes. In the graded time span for river channel formation, the channel slope is a dependent variable controlled by the water and sediment inflows from the drainage basin, and it is the minimum slope needed to transport inflow quantities. The valley slope, which is formed during the much longer geologic time span, is an independent variable for the river during the graded time span. The river slope cannot physically be steeper than the valley slope for a river regime. Therefore, both straight and meandering rivers may be and have been found in nature. For distinctly meandering rivers, the channel slope is significantly flatter than the valley slope. This is because the alluvial valley is usually formed during the very long-term span under various hydrologic and geologic conditions different from those shaping the current channel. In the geologic time span, the valley slope is built up during episodes of deposition whenever the channel slope exceeds the valley slope. But the valley slope is not easily reduced during periods of erosion. Since degradation is inhibited by sediment sorting, the morphological response to sediment deficit is to form a meandering channel which in turn reduces erosion. (See also W90-03626) (Author's abstract)
W90-03634

STABILITY OF INITIALLY STRAIGHT RIVERS.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
P. Diplas, J. F. Kennedy, and A. Odgaard.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 95-105, 5 fig, 31 ref.

Descriptors: *River mechanics, *Channel morphology, *Geomorphology, *Alluvial channels, *Meanders, *River beds, Stability, Braided streams, Straight rivers.

During the last two to three decades stability analysis based on small perturbation theory has emerged as the methodology of choice for predicting meandering or braiding tendencies of initially straight streams. The state of knowledge of this topic is examined, and several stability analyses are reviewed. The most recent theories (by Engelund, Parker, Fredsoe Kuroki, and Blondeaux) give a better understanding of the mechanisms responsible for meandering and braiding, and reasonably good predictions of the stability limits. The width-depth ratio has the dominant influence on the type of river pattern that develops and on the stability limits. However, two other parameters, Shields stress and the rate of depth of undisturbed flow to representative grain size of bed material, are essential to obtain complete stability diagrams. Also, consideration of the roles of bedload and friction are necessary to obtain accurate predictions of instability. (See also W90-03626) (White-Reimer-PTT)

W90-03635

THRESHOLD BETWEEN MEANDERING AND BRAIDING.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
N. Struiksma, and G. J. Klaassen.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 107-120, 6 fig, 2 tab, 26 ref.

Descriptors: *Sediment transport, *River mechanics, *River beds, *Channel morphology, *Alluvial channels, Classification, Model studies, Prediction, Meanders, Braiding.

A prediction method for planforms classification is developed by extending the work by Struiksma on bed deformation in curved alluvial channels. This work involved studying the equilibrium bed topography in curved channels and developing criteria for the spatial amplification of steady bed level perturbations. By comparing the results of the classification method with natural rivers and laboratory channels it is shown that the method yields fair results. A major disadvantage of the proposed classification criterion is that it requires a priori knowledge on channel characteristics like widths and average depths during bankfull discharge. By combining the present method with a method that predicts the channel characteristics, a more universal classification method was obtained. The relation with the classic Leopold and Wolman classification method is shown by introducing Lacey's regime equations into the proposed criterion. (See also W90-03626) (White-Reimer-PTT)
W90-03636

ABOUT EXTREMAL HYPOTHESES AND RIVER REGIME.
Bologna Univ. (Italy). Ist. di Geologia.
A. Lamberti.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. May 1988. p 121-134, 4 fig, 39 ref.

Descriptors: *Alluvial channels, *Sediment transport, *Channel morphology, *Geomorphology, *Hydrological regime, *Fluid mechanics, *Flow characteristics, *Streamflow, Hydraulics, Hypotheses, Sediment transport.

In the field of hydraulics or fluid mechanics various extremal hypotheses have been proposed. Three arguments have been developed regarding these hypotheses: (1) equivalence between the extremum hypotheses leading to the definition of the equivalence class that has been designated m-extremal; (2) arguments against the minimum dissipation rate principle and the m-extremum hypotheses as the narrowing-slope argument; and (3) the proposal of a functional of the mixed type deriving from the transverse equilibrium theory. The set of equivalent extremum hypotheses containing minimum stream power (MSP) and maximum stream transport (MST) are in conflict with the commonly observed fact that a channel reacts to a restriction of the natural width reducing the regime slope. It is suggested that there is no need for an extremum hypothesis, but there is a need for more in-depth analyses of the transverse equilibrium. The variability of alluvial flow characteristics may have some effect which is not accounted for by properly choosing a typical discharge and a typical sediment diameter. Similarly the flow is supposed uniform and secondary currents absent; straight reaches are rare and alternate bars are not well represented by a stochastic lateral motion of sediments; in any case even small channel curvature or low but horizontally extended bed forms may produce a proportionally high transverse sediment transport and modify substantially the section equilibrium. (See also W90-03626) (White-Reimer-PTT)
W90-03637

INFLUENCE OF BANK STABILITY ON REGIME GEOMETRY OF NATURAL CHANNEL.
Queen Mary Coll., London (England).
C. R. Throne.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 135-147, 2 fig, 31 ref.

Descriptors: *Sediment transport, *Stream erosion, *Hydrological regime, *Bank erosion, *Channel morphology, Model studies, Stream profiles.

Bank retreat occurs by a combination of flow erosion and mass failures. Processes and mechanics of retreat depend on the bank material characteristics, but the rate of retreat is controlled by fluvial activity at the bank toe through the state of basal endpoint control. It is hypothesized that the critical height for mass failures of cohesive banks is an intrinsic geomorphic threshold of equal importance to the threshold bed slope for incision in generating complex response. Periods of channel adjustment under formative flows are separated by much longer periods when the form of the channel largely determines the dynamics of flow and sediment movement. During these periods, bank processes operate differently above and below the water surface, resulting in profile changes that would not occur under a steady flow. The verification of the model presented requires detailed accounts of channel evolution to a regime condition, but the results of Osman's aggradation/degradation model quantitatively replicate the main features of the proposed conceptual model. (See also W90-03626) (White-Reimer-PTT)
W90-03638

WIDTH OF REGIME CHANNELS.
R. Bettess, W. R. White, and C. E. Reeve.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 149-161, 5 fig, 1 tab, 19 ref.

Descriptors: *Sediment transport, *Hydrological regime, *Regime channels, *Channel morphology, Width, Comparison studies, Bank stability, Extremal hypotheses, Limiting tractive force, India.

There have been numerous attempts both to explain and to predict the width of regime channels. Approaches compared and discussed include; (1) limiting tractive force; (2) bank slope stability; and (3) extremal hypotheses such as minimum stream power or maximum sediment concentration. The approaches were compared using data from canals in India to predict channel width. The best predictions were provided by the two methods not linked to a particular physical mechanism for determining channel width, that is, empirical regime theory and rational regime theory using an extremal hypothesis. Many approaches only consider mechanisms for channel enlargement without the awareness that the regime width is the result of a balance between different processes involving both erosion and deposition. A full description of the development of channel width may require a knowledge of the distribution of shear stress over the boundary of a channel. (See also W90-03626) (White-Reimer-PTT)
W90-03639

EFFECTS OF GRADATION OF BED MATERIALS AND TRANSPIRATION THROUGH A BED ON BED LOAD TRANSPORT.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
H. Nakagawa, T. Tsujimoto, and S. Murakami.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 163-171, 9 ref.

Descriptors: *Bed load, *Alluvial channels, *Sediment transport, *Channel morphology, *Streambeds, Transpiration, Gravel, Model studies, Size, Permeability.

A gravel bed is composed of widely graded size material and it has high permeability. Prediction of bed load transport rate, and the effects of such characteristics cannot be neglected. The effects of gradation of bed materials and transpiration through a bottom due to the high permeability on bed load transport process have been investigated, based on the mechanism of bed load motion. Although these effects are often interrelated, they were independently treated. The equivalent sand roughness of bed composed of sediment mixture was evaluated against the standard deviation of gradation distribution of sediment size. Then the logarithmic law was applied for flow over a bed composed of sediment mixture, and sediment pickup rate for each grain size was theoretically evaluated using the knowledge for uniform sand. Using the bilogarithmic law instead of the logarithmic law the bed load transport model was applied to the situation with transpiration. Considering the applicability to the non-equilibrium situation and to sediment-mixture transport including the sorting process, the changes of pick-up rate and mean step length for the situation with transpiration from those without transpiration were reasonably evaluated, and the theoretical derivations were verified by laboratory experiments. A bed load transport model constituted by pick-up rate and step length plays a powerful role, because it is still applicable for non-equilibrium conditions and it quite well represents the essential mechanism of bed load motion. (See also W90-03626) (Author's abstract)
W90-03640

CHANNEL CHARACTERISTICS OF THE BRAIDING JAMUNA RIVER, BANGLADESH.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
G. J. Klaasen, and K. Vermeer.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 173-189. 16 fig, 1 tab, 13 ref.

Descriptors: *Bangladesh, *Channel morphology, *River mechanics, Satellite technology, Jamuna River, Stream stabilization, Braided streams.

Channel characteristics of the braiding Jamuna River in Bangladesh were studied within the framework of a feasibility study for a bridge across this large braiding sand-bed river. Planform characteristics were studied on the basis of LANDSAT-images. The variation of some topological and geometrical braiding indices over the years were studied for a total of six reaches. The planform of channel bends was also studied. Cross-sectional characteristics were derived from bed level soundings made by the Bangladesh Water Development Board since 1966/67. From the analysis of the available data it is concluded that over the last decades any lateral shifting of the Jamuna River is not noticeable. This is in contrast with the behavior of the river since the avulsion at the end of the 18th century, which was followed by a Western movement of up to 10 km in some reaches. (See also W90-03626) (Author's abstract)
W90-03641

CHARACTERISTICS OF FLOW AT THE INTERSECTION OF RIVER MEANDERS AND FLOOD RELIEF (CUT-OFF) CHANNELS.
Glasgow Univ. (Scotland). Dept. of Civil Engineering.
J. G. Herbertson, and Y. R. Fares.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 191-202, 6 fig, 2 tab, 12 ref.

Descriptors: *Channel morphology, *Flow characteristics, *Meanders, *Flood channels, Mathematical models, Flood relief channels, Water level, Velocity.

A 2-D mathematical model has been developed for flow around a wide gentle channel bend of uniform section which is capable of successfully predicting the vertical distribution of secondary currents and the transverse water surface slopes at sections around the bend. Combining the bend model with the equation for a broad crested side weir it has been possible to simulate the effect of introducing a flood relief (cut-off) channel into the bend. For all ratios of flood channel bed level to water depth in the main channel the flood channel is more effective in reducing water depth in the bend than in reducing discharge. This is brought about by a local increase in the tangential velocity. The reduction in the water depth is much more significant around the outer bank due to the redistribution of the depth averaged tangential velocity and

the virtual elimination of the super elevation effect. It is believed that the model can be extended to the study of conditions downstream of the intersection. (See also W90-03626) (White-Reimer-PTT)
W90-03642

REGIME BED SLOPES OF CHANNELS WITH A BUOYANT BOUNDARY.
Windsor Univ. (Ontario). Dept. of Civil Engineering.
S. P. Chee, and M. R. Haggag.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. May 1988. p 203-213, 3 fig, 7 ref.

Descriptors: *Channel morphology, *Ice cover, *Hydrological regime, *Streambeds, *Channel morphology, Bed slope, Buoyant covers, Model studies, Sand, Comparison studies.

Laboratory observations were made of the bed slopes of channels with an erodible sand bed in the presence of a buoyant cover made up of polyethylene plastic pellets which simulate an ice cover. In addition, an analytical model was used to predict regime slopes. A comparison of the analytical results with test observations was made in the two types of channels. In the first type, clear water was allowed to circulate in a covered channel with a plane sand bed until equilibrium conditions were attained. In the second case, a sand bed was built up from an initial rigid covered channel by depositing sand from a hopper at the upstream end until an aggraded equilibrium bed was established. The experimentally observed mean bed slopes were in good agreement with those computed from the theoretical formulations. The bedforms found in the tests were in fair agreement generally with those computed from the equations. (See also W90-03626) (Author's abstract)
W90-03643

SEDIMENT SIZE AND CHANNEL CHANGES IN BRAIDED AND MEANDERING GRAVEL-BED STREAMS, UPPER DEESIDE, SCOTLAND.
Aberdeen Univ. (Scotland). Dept. of Geography.
J. Maizels.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 215-230, 12 fig, 29 ref.

Descriptors: *Alluvial channels, *Sediment transport, *Geomorphology, *Scotland, *Channel morphology, *Streambeds, *Sediment transport, Gravel-bed streams, Stability, Floods, Variability.

The possible contrasts in channel sedimentology between two upland gravel-bed streams are examined in order to determine whether differences are in response to a given range of stream flow events, or whether the differences represent an equilibrium adjustment by each stream. Two streams were selected from the upper River Dee catchment in the Grampians of Scotland. The results suggest that while large flood events are responsible for maximum changes in both fine and coarse gravel channel environments, the thresholds for change are highly variable through time and space. Stability of the system will depend not only on variations in sediment input from upstream, but also on the sequence of high flows both during a single storm event and over a period of years, allowing variable periods for bed armour restabilization. The types of change in channel morphology and planform have also been highly variable. The changes on the Dee include overbank avulsion, bar entrenchment, and rapid bank retreat to produce downstream meander migration; occupation and enlargement of smaller channels; and abandonment of the former major thalweg zone, while changes on the Quoich include progressive confinement of the active channel zone over the 1866-1966 period, followed by its small scale and local re-expansion; dissection of former attached bars; and downstream extension of the confluence bar zone. The patterns of change in each channel environment are distinctive, and are likely to reflect the mechanisms and rates of bed sediment removal and downstream transport. (See also W90-03626) (White-Reimer-PTT)
W90-03644

CHANGE OF RIVER REGIME AND GRADED-SEDIMENT DISCHARGE DURING FLOOD.
Tottori Univ. (Japan). Dept. of Civil Engineering.
K. Suzuki, and M. Michiue.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. May 1988. p 231-240, 8 fig, 1 tab, 8 ref.

Descriptors: *Sediment discharge, *Channel morphology, *Sediment transport, *Flood discharge, *Regime streams, Armor coat, Shear stress, Mathematical equations, Particle size.

Sediment discharge characteristics of nonuniform sand bed during the increase and decrease periods of flood discharge are discussed experimentally in connection with the formation and destruction of an armor coat. Sediment discharge for each grain size of sand mixture can be calculated by modifying existing sediment transport formula of uniform sand if the grain size frequency (i sub b) of the bed surface is known. The frequency i sub b varies with the bed shear stress and can be estimated by the proposed equations. The critical conditions of the armor coat destruction is given experimentally by Tau/Tau sub cm = 1.1, where Tau is the bed shear stress and Tau sub cm is the critical shear stress of the mean particles of the armor coat. Calculated curves seem to fit the observed change of sediment discharge with the change of shear stress fairly well although there is some difference between observed and calculated curves mainly due to the uncertainty of the critical condition of the armor coat destruction as determined by the equation. (See also W90-03626) (Author's abstract)
W90-03645

STUDY ON THE STAIRCASE PROFILE AND ARMOURING EFFECTS OF RIVER BED FOR TORRENTIAL STREAMS IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Dept. of Soil and Water Conservation.
C. W. Ho.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 241-250, 6 fig, 2 tab, 7 ref.

Descriptors: *Channel morphology, *Taiwan, *Sediment transport, *Regime streams, Armoring effects, Staircase profile, Streambeds, Regression analysis, Comparison studies.

Due to properties such as narrow shape, steep gradients, and torrential flows, the staircase profile often occurs naturally in Taiwan. The effects of the staircase profile on sediment decrease based on formation and equilibrium theories of river systems has been analyzed, coordinated with indoor flume experiments, and verified with field data. In addition, two regression equations for deposit, flow discharge, and staircase height and interval distance were analyzed. The sediment decrease was 85%-95% for the experimental study, and 82%-94% in Wo-Thuo creek and 79%-91% in Tong Hsi Keng creek for the field verification. The armouring effects results for the flume experiments and the algorithm models were also in close agreement. The results indicate the staircase profile has two functions: (1) stabilizing the river bed; and (2) decreasing the hydraulic energy due to hydraulic jump through the special profile. (See also W90-03626) (White-Reimer-PTT)
W90-03646

ESTIMATION OF FRICTION FACTOR IN NATURAL STREAMS.
Department of Agriculture for Northern Ireland, Belfast.
N. N. J. Higginson, and H. T. Johnston.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. May 1988. p 251-266, 112 fig, append.

Descriptors: *Bed load, *Hydraulic roughness, *Flow friction, *Northern Ireland, *Channel morphology, Comparison studies, Velocity, Einstein-Barbarossa method, Engelund method, White method, Mathematical equations.

The estimation of friction factor is of great importance in assessing the flow capacity of a channel. Therefore, a study relating flow to channel geometry and bed material was undertaken on Northern Ireland rivers using the Einstein-Barbarossa, and Engelund and White methods of predicting channel capacity. It was found that the dimensionless Einstein-Barbarossa bed form resistance parameters departed considerably from the Einstein-Barbarossa curve. The basis of comparison that was used was the percent of calculated values which lie within a factor of 2 of the observed values. The Engelund method of estimating a channel stage discharge relationship gave poor predictions. No prediction could be made for bed materials having D sub 50 (sieve sizes passing 50% by weight) sizes less than 35 mm, and above this threshold estimates were approximately 15% of true values at bankfull conditions. The White method was considerably better and gave 79% with some values being up to a factor of 8 times the observed. A new equation was derived as an empirical best fit equation for use with the Manning formula to evaluate bank-full mean velocity. The equation is dependent upon velocity and may admit more than one solution or no unique solution for any given site. The new method achieved 89% of values within a factor of 2 and in all cases was less than a factor of 4 off the observed values. The new method has been shown to give a better estimation of roughness coefficient than the White method when applied to Northern Ireland rivers. (See also W90-03626) (White-Reimer-PTT)
W90-03647

PREDICTION OF MEAN BED AND WALL BOUNDARY SHEAR IN UNIFORM AND COMPOSITELY ROUGH CHANNELS.
Leicester Univ. (England). Dept. of Engineering.
T. P. Flintham, and P. A. Carling.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 267-287, 13 fig, 1 tab, 17 ref.

Descriptors: *Hydraulic roughness, *Channel scour, *Channel morphology, *Streambeds, Model studies, Mathematical equations, Rough channels, Wall boundary shear.

Experimental procedures and data compilations are presented which relate to the prediction of mean bed and wall boundary shear in uniform and compositely roughened channels. The experimental program was carried out in a tilting 13 m long trapezoidal channel, and the discharge was measured using an orifice plate installed to British Standard specifications and the flow depth controlled by a louvre-type tailgate. The roughness elements consisted of 'single sized' rounded river gravels, glued a single layer deep to plywood lining boards. Equations were derived that provide a quick and simple method of determining the mean bed and side-wall shear stress in straight symmetrical trapezoidal and rectangular channels (45 degrees < Theta < 90 degrees), in which the bed roughness is equal or greater than the side-wall roughness. The model should be applied with caution to larger-scale channels as Reynolds' numbers will probably exceed the upper limit of the experimental range. The model is suitable for stable subcritical and super-critical flows. (See also W90-03626) (White-Reimer-PTT)
W90-03648

MULTIPLE BARS AND STREAM BRAIDING.
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
Y. Fujita, and Y. Muramoto.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 289-300, 13 fig, 1 tab, 4 ref.

Descriptors: *Channel morphology, *Alluvial channels, *Sediment transport, *Braided streams, *Sandbars, Width, Bar formation, Modes, Hydraulic properties, Mathematical equations.

Detailed hydraulic experiments were carried out on the behavior of multiple row bars and the formation of braided streams in three flumes with widths of 0.5, 1.8, and 3.0 m. The number of bars across the width of channel is referred to as the

mode; higher modes implying division of the stream into many parallel sections. The higher modes of bars were observed to alter to lower ones and braided patterns appeared in cases with small depths. Bars in high modes proved to have the same hydraulic properties as alternate bars. Several results of studies on alternate bars could be applied to predict behavior of multi-mode bars. It was concluded that the formations of bars in various mode and braided streams can be predicted by using the diagrams developed which allow for the co-existence of several modes. However, it is necessary to examine the formative process quantitatively from the viewpoint of sediment transport in order to predict the time required for the alternation of the bar mode and the appearance of braided streams. (See also W90-03626) (Author's abstract)
W90-03649

BED FORM CONFIGURATION OF A RIVER BEND.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
H. Y. Lee, and H. Y. Ho.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 301-316, 17 fig, 9 ref.

Descriptors: *Sediment transport, *River beds, *Streambeds, *Channel morphology, Height, Wavelengths, Bed form, Model studies, Bends, Water currents.

A series of model tests were conducted to investigate the bed form characteristics, including height, wave length and orientation of a river bend. It was found that there are significant differences between the bed form characteristics of a river bend and those of a straight channel. Hence, traditional bed form prediction criteria cannot be applied to a curved channel. In a river bend, significant bed forms were observed: (1) The bed form height and wave length were strongly correlated to the water depth, local densimetric Froude number and strength of secondary current. (2) The dimensions of the bed forms grew in a streamwise direction. (3) The orientation of the bed forms were strongly correlated to the strength of the secondary current and the transverse bed slopes. In the early developing stage, a tremendous amount of sediments are carried from outside toward inside bend by secondary currents, hence, a significant deviation angle is formed between the bed form crestline and the line perpendicular to the mean flow direction. As time proceeds, inward movement of sediments reduces the deviation angle decreases accordingly. (See also W90-03626) (Author's abstract)
W90-03650

REGIME ASPECTS OF FLOOD CONTROL CHANNELIZATION.
Northwest Hydraulic Consultants Ltd., Edmonton (Alberta).
For primary bibliographic entry see Field 4A.
W90-03651

APPLICATION OF BED STABILITY CRITERIA IN RIVERS WITH CONSECUTIVE RUN-OF-RIVER POWER PLANTS.
H. Scheuerlein.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 355-364, 7 fig, 5 ref.

Descriptors: *Alluvial channels, *Scour, *West Germany, *Flow pattern, *River beds, *Sediment transport, Erosion, Controlled rivers, Hydroelectric power, Barrages.

Using the Lech River in Bavaria as an example, the flow phenomena and the sediment behavior in an almost completely controlled river were explained. For one selected range between two consecutive barrages the stability of the river bed was investigated by means of five different approaches (HJULSTROM, NEILL, MEYER-PETER, SHIELDS, ZANKE). It was determined that the existence of an uninterrupted chain of barrages does not necessarily mean that sediment motion comes to a complete standstill. The barrages simply function as fix-points in the longitudinal section of the river. Between these fix-points sediment motion will go on and substantial rearrangement of the bed configuration will take place. The actual behavior of the river bed between two consecutive barrages depends on the topography of the river course rather than on the backing up effect of the downstream barrage. The backing up effect diminishes with increasing discharge and under certain circumstances disappears completely. Consequently the range of undisturbed flow and therefore the range of unhindered erosion of the bed increases. The simultaneous application of five different approaches concerning verification of bed stability showed that criteria based on critical velocity have the tendency to produce optimistic results for low flow velocities ($v < 2$ m/s) and conservative results for high flow velocities ($v > 2$ m/s), compared with stability criteria based on critical shear stress. Out of all methods that were applied, the one from SHIELDS proved to be the most balanced one, neither producing too conservative nor too optimistic results. (See also W90-03626) (Author's abstract)
W90-03653

REGIME CHANGES IN THE CALEDON RIVER ASSOCIATED WITH WELBEDACHT BARRAGE: PHYSICAL MODEL, PROTOTYPE AND THEORETICAL CORRELATIONS.
Department of Water Affairs, Pretoria (South Africa).
J. M. Jordaan, and D. Clark.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 375-384, 6 fig, 2 tab, 2 ref.

Descriptors: *Sediment transport, *Regime streams, *Hydrological regime, *South Africa, *Reservoir storage, Model studies, Equilibrium condition, Sediment transport, Welbedacht Reservoir.

Historical sedimentology and hydrological records were compared with experimental observations obtained by means of a scale model of the Welbedacht Reservoir in South Africa and with theoretical and empirical relationships reported by Rooseboom and Van Vuuren. The results indicated that a dam that is situated in an area where the sediment yield is high should be of the barrage type and operated with the retention water level kept to the minimum for the required storage. The numerical and physical modelling techniques, when combined with adequate field data and surveys for verification and calibration, showed good agreement for the equilibrium profiles and provided valuable information for the prediction of future behavior of rivers and reservoirs undergoing regime changes. An equilibrium sedimented condition is expected to be reached on the Welbedacht Reservoir within a decade, stabilizing at 10 million cu m or 9% of the original capacity. At this time approximately 225 million cu m of sediment influx will have occurred (twice the original storage volume) and after a reservoir lifetime of ca 25 years; when run-off some 250 times its volume will have occurred. At that stage the system would again be considered to be in a natural regime or equilibrium state. (See also W90-03626) (White-Reimer-PTT)
W90-03655

EFFECTS OF EXTENSIVE DREDGING ON THE RIVER REGIME.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
S. Kornis, and I. A. Laczay.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 385-394, 9 fig, 3 ref.

Descriptors: *Hungary, *Danube River, *Dredging, *Channel morphology, *Hydrological regime, *Sediment transport, *Sedimentation, Model studies, Field studies, Dredging effects.

Long-term and extensive dredging caused significant changes in the channel-regime and in the low-flow conditions along the Danube river in Hungary. To explore the former and to assess the further consequences of this activity, both hydraulic model tests and field investigations were performed. The hydraulic model tests confirmed that within the river channel dredging pits must not be made shorter than the channel width and wider than about half of it to avoid undesirable flow-disturbances and bed-erosion. However, the excavation can be deeper when constructing very mild upstream and downstream slopes for the pit, and the side-walls can be excavated vertically. Extensive field surveys and samplings on a 60 km-long reach of the Danube river downstream of Budapest confirmed that in excavating troughs with dimensions of 500 to 1000 x 100 to 150 x 2 to 4 m no major refilling occurred for several years. The measured/calculate channel-balance of 15 years (including the excavated volumes) has shown a certain refilling process which conforms to the natural regime of the river-reach. Information available on the actual sediment-transport conditions were insufficient to confirm the channel-processes observed or to provide reasonable predictions of the consequences of further dredging activities. (See also W90-03626) (Author's abstract)
W90-03656

EFFECT OF BOAT TRAFFIC ON RIVER REGIME.
Forth River Purification Board, Edinburgh (Scotland).
P. N. Garrad, and R. D. Hey.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 395-409, 7 fig, 14 ref.

Descriptors: *Bank erosion, *Bank stabilization, *Sediment transport, *England, *Boating, *Wave action, Bank vegetation, Wave wash, Piles, Model studies, Aerial photography.

The Norfolk Broads are a series of interconnected lakes and rivers in Eastern England that discharge into the sea at Great Yarmouth. Since 1945 the width of Broadland rivers has increased dramatically, mainly due to wave attack by boat traffic aggravated by a decline in bankside vegetation. The bank erosion problem on the Yare and Bure river systems has become serious enough in recent years for considerable lengths of the bank to be piled in order to prevent undercutting of the flood walls. The increase in river width over historical times was shown by comparing Ordance Survey maps dated 1883, 1946, 1963, and 1976. For the period 1883-1946 the rate of band retreat was of the order of 0.3 to 0.6 cm per year, whereas current rates range from 6.0 to 16.0 cm per year for the period 1946-1976, indicating channel width may be changing by up to 32 cm per year. Other means used to determine the extent and mechanisms involved in bank erosion included: (1) aerial photographs; (2) sediment transport models; and (3) direct surveys of river cross sections. The progressive increase in river width means that longer lengths of bank will need to be piled to prevent the channel encroaching within 5 m of the flood wall, unless erosion can be halted or reversed. In the short term, the most effective way of reducing river bank erosion is by controlling boat wash. This can be achieved by reducing boat speeds to 5 mph or less in most regions. Additionally, suitable management to increase the resistance of the banks to erosion by regrading and introducing protective vegetation may also prove appropriate. (See also W90-03626) (White-Reimer-PTT)
W90-03657

USE OF AN EMPIRICAL METHOD (EROSION POTENTIAL METHOD) FOR CALCULATING SEDIMENT PRODUCTION AND TRANSPORTATION IN UNSTUDIED OR TORRENTIAL STREAMS.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 2J.
W90-03658

EARTHQUAKES AND RIVER REGIMES.
Central Water and Power Research Station, Poona (India).

A. Bapat.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 423-429, 10 ref.

Descriptors: *Earthquakes, *Tsunamis, *Regime streams, Flooding, Seismic effects, Slopes, Dams, Sedimentation, Water quality, History.

The occurrence of earthquakes in river regimes can affect rivers in upper ridges, plains and delta regions. These effects are principally due to faulting, shaking, ground failures and tsunamis. The pre-seismic, co-seismic, and post-seismic effects on rivers in India, New Zealand, and Latin America were studied. The most significant pre-seismic effects are the change in ground level, either sinking or upheaval of land. If the slope is reduced, the velocity of river water is reduced and causes additional deposition of sediments and more spreading of water during flood periods. If the slope is increased the velocity of water is increased and excessive erosion occurs. The greatest co-seismic effect is the massive displacement of geological materials as a result of liquefaction in river regime encompassed by a high isoseismal. Due to liquefaction, landslides may occur and the flow of a river may be temporarily blocked due to the formation of natural dams. The major post-seismic effects are changes in river courses, heavy sedimentation, rise in bed level, change in granular and chemical composition of sediment, and changes in water quality. In order to assess the likely effects of a potential earthquake the following procedure should be used: (1) Determine from a list of historical earthquakes whether there is any reasonable and finite probability of the occurrence of a medium to large earthquake during the foreseeable future or the projected period of the study; and (2) Work out the likely levels of accelerations due to a predicted earthquake at different distances and its effect on local geology. Plot the likely isoseismals for a few probable locations of epicenters, and examine this with reference to the river regime. Various likely effects could then be worked out. Future river valley development projects could be planned so as to mitigate the earthquake effects. (See also W90-03626) (White-Reimer-PTT)
W90-03659

FLOOD GEOMORPHOLOGY.
John Wiley & Sons, New York. 1988. Edited by V.R. Baker, R.C. Kochel, and P.C. Patton. 503p.

Descriptors: *Geomorphology, *Floods, *Historic floods, *Flood plain management, Flood control, Flood damage, Flood channels, Flood basins, Flood plains, Flood profiles, Regional floods, Research priorities, Rainfall-runoff relationships, Land forming, Geologic control, Canada, China, India, Israel, Germany, Jamaica, New Zealand.

Flood geomorphology can be considered to be the study of the role of floods in shaping the landscape, including the analysis of flood causes, flood processes, resistance factors to flood-induced landscape change, and changes in flood-related processes and forms through time. Geomorphologists are also interested in how the landscape affects flood processes over varying time scales. A scientific, as opposed to an engineering or statistical, approach is needed which is not based on the sometimes misleading probability estimates; the flooding process is of intrinsic scientific interest, regardless of concerns for designing structures or estimating risk. Because of its accelerating scientific growth, flood geomorphology is an obvious candidate for research symposia and published proceedings. To retain the flavor of actively evolving research, various active researchers were contacted as chapter authors, as well as contributors to most of the major topics for the newly defined subdiscipline: flood geomorphology. Contributions were organized into five parts: (1) external controls and geomorphic measurements; (2) flood processes; (3) floods, climate, landscape; (4) paleofloods; and (5) environmental management. Because most flood research concerns rainfall-runoff flooding, this topic receives major emphasis, as does modern/Holocene flooding. Extensive flood geomorphic experience is drawn from Canada, China, India, Israel, Germany, Jamaica, and New Zealand, in addition to the immense variety of the American landscape. (See W90-03662 thru W90-03688) (Fish-PTT)
W90-03661

FLOOD CLIMATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
B. P. Hayden.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 13-26. 9 fig, 14 ref.

Descriptors: *Regional floods, *Floods, *Flood basins, *Climatic zones, *Climatology, *Meteorological data collection, Classification, Atmospheric water, Orography, Mountains, Precipitation, Snow, Moisture availability, Water resources development, Vegetation, Soil classification, Geomorphology.

A need has been established for a global classification of flooding and for a map of the resulting flood climate types. Although variability in basin characteristics prohibits regionalization on a global basis, the meteorological causes and potential for flooding can be classified and regionalized. Flood climate regions are delineated on the basis of meteorological causation, based on the potential available floodwater in the atmosphere and on the land and on the weather systems that result in the discharge from the atmospheric reservoir of snow and ice on the land. The presence of mountains that orographically enhance precipitation and tend to have winter storage of snows complicate the latitudinal and longitudinal symmetry of the distribution of the flood climate regions. Nonetheless, the resulting regions should be internally homogeneous in terms of the kinds of flood-generating events, moisture availability, and other aspects of the water resources of the regions defined. This classification should stand as a valuable addition to the often used charts of global climate, vegetation, soils, and fluvial geomorphologic features. (See also W90-03661) (Fish-PTT)
W90-03662

FLOOD HYDROCLIMATOLOGY.
Louisiana State Univ., Baton Rouge. Dept. of Geography and Anthropology.
K. K. Hirschboeck.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 27-49. 14 fig, 104 ref.

Descriptors: *Floods, *Hydrologic systems, *Climatology, *Time series analysis, Variability, Statistical analysis, Mathematical studies, Atmospheric physics, Physical properties, Historic floods, Climatic data, Meteorological data collections, Air circulation, Flood plain management, Hydroclimatology.

The methodologies that have been developed and refined through the years to manipulate, model, and predict flood values have become increasingly sophisticated. The cross-discipline of hydroclimatology is an approach to studying hydrologic events within their climatological context. By focusing on atmospheric inputs to flooding, hydroclimatology provides one way to integrate the physical sources of variability in a hydrologic time series with the statistical properties of the varying series itself, thus both enhancing our understanding of the flooding process and improving the quantitative assessment of its variability. In a hydroclimatic approach to flood analysis the events recorded in a flood series are viewed not only as numerical values, or as isolated hydrologic occurrences, but as real-world physical events occurring within the context of a history of climatic variations in magnitude and frequency. The physical basis of the approach emerges when these events are analyzed within the spatial framework of regional and global networks of changing meteorologic features and circulation patterns. Although climate has been incorporated into flood analyses in a variety of ways, given the broad space-time domain of hydroclimatic activity, there is a great need to re-evaluate certain assumptions about how floods vary over time in relation to climate and to re-examine other current issues in flood hydrology from a new hydroclimatic perspective. (See also W90-03661) (Fish-PTT)
W90-03663

DRAINAGE BASIN MORPHOMETRY AND FLOODS.
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
P. C. Patton.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 51-64. 11 fig, 1 tab, 67 ref.

Descriptors: *Geomorphology, *Catchment areas, *Flood basins, *Unit hydrographs, *Rainfall-runoff relationships, *Drainage patterns, Networks, Water yield, Sediment yield, Runoff forecasting, Model studies, Geomorphology, Flood routing, Flood hydrographs, Streamflow forecasting, Stochastic hydrology, Hydrologic aspects, Geologic control.

Drainage basins are the fundamental units of the fluvial landscape, and a great amount of research has focused on their geometric characteristics. The analysis of basin morphometry has been extended to include the interrelationships between network characteristics and the resulting water and sediment yields. Models of runoff, based on the geomorphic description of the drainage basin coupled with hydrologic concepts of flood storage and flood routing, have been used to create synthetic unit hydrographs; these geomorphic unit hydrographs are produced by combining the known probability of stream network topology with a stochastic model of storage and water transfer between stream segments to create water runoff models that simulate the actual hydrologic processes. The interdependence of hydrology, geology, and drainage network composition provides insight into the evolution of drainage systems and the relative geomorphologic importance of hydrologic processes of differing magnitude and frequency. Two problems have limited the extension of these methods: (1) a still incomplete understanding of the interrelationship between rainfall-runoff events of varying magnitude and frequency and the composition of the drainage net; and (2) a lack of full understanding of the methodology of the geomorphic unit hydrograph. The evolution of drainage basins is governed by the interplay of flood events that work to extend the drainage net and the recovery time of the basin, which is controlled by climate and geology. (See also W90-03661) (Fish-PTT)
W90-03664

GEOMORPHIC MEASUREMENTS AFTER A FLOOD.
Geological Survey, Lakewood, CO.
G. P. Williams, and J. E. Costa.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 65-77. 3 fig, 1 tab, 54 ref.

Descriptors: *Flood flow, *Channel morphology, *Geomorphology, Erosion, Sediment transport, Deposition, Dissolved solids, Flood damage, Flow characteristics, Historic floods, Flood data, Particle size, Hydraulic properties, Surface water, Streamflow forecasting, Flood peak, Sedimentary structures, Discharge capacity, Roughness coefficient, Spatial distribution, Vegetation effects.

Stream channels are among the most dynamic components of the landscape. Through them, energy and mass (streamflow containing solid and dissolved sediment loads) are transferred from one location in the landscape to another. Channels are therefore a logical and efficient place to investigate the geomorphic effects of force, resistance, erosion, transportation, and deposition. Any high flow of water that overtops a channel's banks is a flood, during which a great deal of geomorphic transformation takes place. Studying the geomorphic effects of floods offers some of the most wide-reaching and efficient ways to understand present, and interpret past, earth processes. However, the observations, measurements, and data have been inconsistent. Aspects that deserve more attention are hydraulic characteristics associated with sediment entrainment and deposition, evidence of debris flows, and well-organized plans for monitoring the landscape's postflood recovery. Features that

should be observed, measured, or estimated after a flood include: evidence of a debris flow or water flood; cross-sectional flow area; water surface width; slope of water surface and of channel; peak flow mean velocity and water discharge; roughness coefficient; spatial distribution and volume of deposits; primary sedimentary structures; particle sizes; grain lithologies, shape, and roundness; and vegetation affected by the flood. (See also W90-03661) (Fish-PTT)
W90-03665

FLOOD EROSION.
Arizona Univ., Tucson. Dept. of Geosciences.
V. R. Baker.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 81-95. 15 fig, 52 ref.

Descriptors: *Geomorphology, *Flood damage, *Flood channels, *Channel erosion, *Channel morphology, Flood discharge, Sediment discharge, Vegetation effects, Flood stages, Stream banks, Alluvial channels, Equilibrium, Flood frequency, Regime channels, Regime streams.

Geomorphic erosion can be analyzed as the dynamic action of forces on resistant geologic materials. Because floods impose higher than average forces on stream bed and bank materials, their study is critical to all work in fluvial geomorphology. In studying flood erosion an important distinction must be made between alluvial and nonalluvial river channels. Alluvial channel characteristics are established by variations in the discharge of water and sediment, as modified by vegetation growth along the banks. Such channels are self-formed through the independent adjustment of morphologic variables, and are characterized by a tendency to adjust toward equilibrium or regime. Nonalluvial river channels are characterized by sufficiently high boundary resistance that an equilibrium or regime adjustment among sediment capacity, water discharge, and morphologic variables is not possible for most flood stages. Extremely intense, rare floods may overcome the high threshold for erosion in such channels, producing boundary roughness adjustments that tend to re-establish regime. However, such systems are sediment-limited, and true equilibrium cannot be achieved. In contrast, low-threshold systems are extremely sensitive to floods of lower intensity and high frequency; changes in sediment and water discharge during a large event generated very rapid responses in channel geometry and bed roughness according to regime relationships. (See also W90-03661) (Fish-PTT)
W90-03666

SEDIMENT TRANSPORT BY FLOODS.
Oregon State Univ., Corvallis. Coll. of Oceanography.
P. D. Komar.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 97-111. 12 fig, 1 tab, 43 ref. Planetary Geology Program of the NASA Grant NSG-71718.

Descriptors: *Geomorphology, *Sediment transport, *Flood discharge, *Flood damage, *Sedimentation rates, *Sediment erosion, Sediment-carrying capacity, Bed load, Bed-load discharge, Flow velocity, Suspended load, Particle size, Topography, Field tests, Estimating.

Exceptional floods can erode and transport vast quantities of sediments, resulting in major modifications of the landscape. Understanding the processes of sediment transport and evaluating the rates and quantities offer difficult enough problems under normal flow conditions; with floods the task is a true challenge. Application of sediment transport formulas to floods can require extrapolations by factors of 100 or more beyond the original data base. Attempts to make estimates of transport rates of sediments carried by a flood can lead to questionable results. However, the trends are clear: the transport rate of bed load is proportional to the flow velocity with an exponent on the order of 3-5 so that floods can result in dramatic increases. The increase in the suspended load may be still greater, direct measurements in a typical river showing a 1000-fold increase during floods. The quantity of the fine-grained washload can play a significant role in determining the total quantity of sediment transported during a flood and thus in the amount of erosion. The greater the strength of the flood flow, the larger the size gravel and boulders entrained and transported. Major topographic changes produced by floods attest to their ability to entrain and transport huge quantities of sediments. However, due to the scale of such events, especially in comparison with our laboratory and field studies of sediment transport processes, quantitative assessments of sediment transport rates or flow competence evaluations require considerable extrapolations and therefore can yield only very rough estimates. (See also W90-03661) (Fish-PTT)
W90-03667

RHEOLOGIC, GEOMORPHIC, AND SEDIMENTOLOGIC DIFFERENTIATION OF WATER FLOODS, HYPERCONCENTRATED FLOWS, AND DEBRIS FLOWS.
Cascades Volcano Observatory, Vancouver, WA.
J. E. Costa.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 113-122. 5 fig, 2 tab, 54 ref.

Descriptors: *Rheology, *Geomorphology, *Flooding, *Flow characteristics, *Erosion, *Floods, *Sediment transport, Flow discharge, Alpine regions, Basins, Sediment concentration, Strength, Rainstorms, Sediments.

When investigating floods, especially in small, mountainous basins, one of the most important tasks is to properly identify the flow process that occurred in the basin. Variation in flow processes are caused mainly by the character and content of sediment entrained in the flow. The possible flow processes can be divided conveniently into three categories: (1) water floods, (2) hyperconcentrated flows, and (3) debris flows. Each category has some unique and diagnostic effects and products. However, in nature, there exists a continuum of flow conditions and sediment concentrations. Because of the fundamental rheologic differences among the three flow processes, it is possible to reconstruct the correct flow process accurately from geomorphic and sedimentologic evidence. Landforms and sediment characteristics are diagnostic of the different flow processes because of the rapid increase of shear strength with increasing sediment concentrations. Difficulties in interpretation of process may occur when a single rainstorm produces multiple types of flows in the same basin. However, the correct identification of flow processes is essential for understanding sediment mobilization, routing, and storage, proper design of mitigation measures, and accurate delineation of hazard zones. The solution is accurate landform and sediment interpretation in the field. (See also W90-03661) (Fish-PTT)
W90-03668

FLOOD SEDIMENTATION IN BEDROCK FLUVIAL SYSTEMS.
Arizona Univ., Tucson. Dept. of Geosciences.
V. R. Baker, and R. C. Kochel.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 123-137. 20 fig, 4 tab, 20 ref.

Descriptors: *Sediment discharge, *Fluvial sediments, *Flood flow, *Geomorphology, *Channel morphology, *Channel flow, *Bedrock, Channel erosion, Flow channels, Flow discharge, Flood stages, Flood peak, Suspended sediments, Suspended load, Bed load, Wash load, Particle size, Flumes, Field tests, Historic floods, China.

The distinction between alluvial and nonalluvial river channels is critical for the analysis of sedimentation by large, rare flood events. Where bedrock has sufficient erosional resistance, narrow, deep confined channels may result. The high discharges of extraordinary floods are accommodated by exceptionally great flow depths. The rapid fall in stage that follows from the flood peak through narrow, deep bedrock channels causes suspended sand and silt to be deposited at high flood levels in slackwater areas, and preserved as the flood rapidly recedes. Such deposits allow the reconstruction of past floodwater surface profiles, in turn allowing the calculation of the flood magnitude. Water floods may have sufficient turbulence to separate entrained sediment into the three primary modes of transport: bed load, suspended load, and wash load. Channel margin areas may accumulate slackwater deposits of relatively coarse suspended load and wash load. Even very large rivers, such as the Chang Jiang (Yangtze River, China), may display such sedimentary phenomena in reaches with appropriate geometry and erosional resistance. Processes of tributary backflooding and associated slackwater sedimentation may be studied by simulation in flume experiments. The flume studies and their comparisons with field studies are summarized to increase the chances for selecting the best sites for slackwater paleoflood studies along bedrock rivers. (See also W90-03661) (Fish-PTT)
W90-03669

RIVER FLOOD REGIME AND FLOODPLAIN STRATIGRAPHY.
Wright State Univ., Dayton, OH. Dept. of Geology.
G. R. Brakenridge.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 139-156. 15 fig, 1 tab, 33 ref.

Descriptors: *Geomorphology, *Flood plains, *River flow, *Regime channels, *Stratigraphy, *Channel flow, *Fluvial sediments, Alluvial plains, Historic floods, Flood stages, Flood frequency, Fluvial sediments, Meanders, High flow, Arizona, Missouri, Tennessee, Vermont, Poland, West Germany, Austria.

In order to understand how river flood regimes affect flood plain stratigraphic and facies development, it is necessary to examine the fundamental processes involved in flood plain genesis, relationships between flow stages of various frequencies and facies geometries, and the effects of alternating periods of fluvial stability and activity on flood plain sedimentation. Channel meandering, in-channel high flows, and overbank high flows are all natural processes that occur together to produce river flood plains. Seven cross sections of late Quaternary flood plain alluvium, from Arizona, Missouri, Tennessee, Vermont, Poland, Bavaria, and Austria are given as examples of flood plain stratigraphy and facies. Fluvial history can be described from studying flood plain sequences and flood plain studies provide valuable perspectives on flood-related fluvial processes at time scales of 100-10,000 years. Flood plain stratigraphy is shown to be a complex, but decipherable, record of present and past river flood regimes, of other aspects of river history, and of the internal and external geomorphic variables that control such history. (See also W90-03661) (Fish-PTT)
W90-03670

FLOODS; DEGRADATION AND AGGRADATION.
Arizona Univ., Tucson. Dept. of Geosciences.
W. B. Bull.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 157-165. 3 fig, 1 tab, 29 ref.

Descriptors: *Sediment transport, *Geomorphology, *Floods, *Aggradation, *Degradation, *Fluvial sediments, Streamflow, Sedimentation rates, Erosion rates, Equilibrium, Terracing, Terrace channels, Base flow, Flood frequency, Arid zone, Humid areas, Particle size, Headwaters, Debris basins, Mountains.

Floods are important output processes of fluvial systems. The effects of floods on the modes of operation of stream subsystems range from minimal to profound. Variations in spatial or temporal rates of aggradation or degradation of streams during floods are a function of whether or not a given reach is close to or distant from equilibrium or threshold conditions. Past equilibrium or threshold conditions are represented by terraces, which generally may be considered as time lines in stream systems. Net degradation cannot occur over long-term absence of base-level fall, even where floods are frequent. Humid-region streams will tend to

degrade more rapidly than will arid-region streams because their greater annual stream power tends to be more than sufficient to transport sediment yielded from hillslope subsystems. Massive influxes of coarse-grained sediment into streams increase resisting power so much that aggradation overwhelms stream subsystems. It is important to recognize departures from equilibrium conditions and how different sizes of departures influence responses to flood events. Headwater reaches have the greatest tendency to degrade, and depositional basins have an increasing tendency to aggrade downslope from where streams emerge from mountains. Prediction of the effects of floods should take into account temporal variations of the ratio of stream power/resisting power that are controlled in part by feedback mechanisms. (See also W90-03661) (Fish-PTT)
W90-03671

GEOMORPHIC IMPACT OF LARGE FLOODS: REVIEW AND NEW PERSPECTIVES ON MAGNITUDE AND FREQUENCY.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
R. C. Kochel.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 169-187. 9 fig, 2 tab, 43 ref. NSF Grant EAR 77-23025.

Descriptors: *Geomorphology, *Stream erosion, *Flood plains, *Flood discharge, *River systems, *Channel morphology, Flood frequency, Flood channels, Sediment transport, Hydrological regime, Climates, Catchment areas, Sediment load, Vegetation, Soil types, Cohesion, Flashy streams, Hydrographs, Bed load, Flow velocity, Turbulent flow, Flood peak.

The relative role of infrequent, large-magnitude floods (those that equal or exceed the discharge expected by the 50-year flood) on stream channels and flood plains has been the focus of considerable debate for many years. Considerably different conclusions can be drawn from observations of floods on a given river, depending on whether one looks at the amount of sediment transported or the impact of floods upon the landscape. Climate and hydrology are important parameters influencing the role of floods of differing magnitude and frequency. Striking contrasts in river response to large floods also exist within similar climates. The major geomorphic variables affecting the response of rivers to large-magnitude, infrequent floods are: (1) drainage basin factors (climatic, hydrology, basin morphometry, sediment load, vegetation, and soils); and (2) river channel factors (channel gradient, channel and flood plain geometry, channel morphology, and bank cohesion). Streams that experience major geomorphic changes during large floods appear to be characterized by flashy hydrographs, high channel gradient, abundant coarse bed load, relatively low bank cohesion, and channel cross-sections that enable flood discharges to be accompanied by deep, high velocity flows where macroturbulent flow phenomena can be initiated and maintained. The factors coincident with streams showing dramatic response to floods but having less dependence on climate are high channel gradient, coarse bed load, and channel geometry. Dramatic channel response to large floods occurs primarily when peak flood velocity and depth exceed threshold values necessary for the development and maintenance of macroturbulence. (See also W90-03661) (Fish-PTT)
W90-03672

HYDROLOGIC ASPECTS OF FLOODS IN EXTREME ARID ENVIRONMENTS.
Hebrew Univ., Jerusalem (Israel).
A. P. Schick.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 189-203. 14 fig, 2 tab, 39 ref.

Descriptors: *Arid climates, *Maximum probable floods, Fluvial sediments, Sedimentary structures, Regional floods, Rainfall-runoff relationships, Catchment areas, Flood frequency, Israel, Egypt.

Well over one-half of the extreme arid area of the globe is not covered by sand dunes, and is therefore susceptible to runoff generation and, given sufficient rainfall intensities, to flooding. Over most of the extreme arid areas, fluvial forms are indelibly imprinted on the landscape. In comparison with values for nonarid environments, the maximum probable floods for hyperarid environments as estimated by the slope-area method are clearly lower. The difference is about one-half order of magnitude for small catchments to one order of magnitude for the large ones. A true interregional comparison of floods in hyperarid environments is not possible at this stage of our knowledge. Discussion of floods in extreme arid environments is limited to the results of studies done in the southern Negev Desert (southern Israel) and in the Sinai region (northeast Egypt). Indirect methods for magnitude and frequency determination are bound to play an increasingly important role in the understanding of floods in hyperarid environments. (See also W90-03661) (Fish-PTT)
W90-03673

FLOODS IN COLD CLIMATES.
British Columbia Univ., Vancouver. Dept. of Geography.
M. Church.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 205-229. 23 fig, 3 tab, 49 ref.

Descriptors: *Cold regions, *Floods, *Geomorphology, *Hydrologic cycle, Snow cover, Ice cover, Runoff, Flood forecasting, Hydrometeorology, Snowmelt, Rainstorms, Glaciohydrology, Precipitation, Flood channels, Flood frequency, Landslides, Moraines, Frequency analysis, Watersheds, River flow, Classification.

Cold climates are those in which the hydrologic cycle is influenced by the seasonal (or perennial) accumulation of snow or ice. The period of accumulation is sufficiently long to alter the pattern of runoff which would otherwise be determined by the distribution of precipitation. The range of normal hydrometeorologic mechanisms that may produce flood flows in nival regions (regions in which snow cover occurs for longer than one month in 50% of the years) complicates analysis and projection of extreme flows. A classification of floods in cold regions includes: (1) hydrometeorological floods: nival (snowmelt, glacier ice melt), rainstorm, and mixed (rain on snow); (2) channel blockage by snow and ice: channel blockage by ice (winter jams, breakup jams), icing, and jokulhlaups; and (3) azonal floods (moraine or landslide failures). For frequency analysis nival floods introduce extraordinary complications for the selection of successive independent events since snow conditions over the watershed may effectively impart an unusually long 'memory' into the flow record. The relatively flat frequency plots exhibited by such populations of nival floods suggest that they perform relatively limited work to change river channel form. Abrupt changes in river morphology more often are associated with major rainstorm floods. Rivers with relatively high thresholds for fluvial work--particularly, for moving channel bed sediments--and under influence of strongly skewed flow distributions, may exhibit a catastrophic response: most of the geomorphologic work is accomplished by relatively rare floods. (See also W90-03661) (Fish-PTT)
W90-03674

DEFINITION OF FLOOD PLAINS ALONG ARID-REGION RIVERS.
Arizona State Univ., Tempe. Dept. of Geography.
W. L. Graf.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 231-242. 7 fig, 65 ref.

Descriptors: *Stream erosion, *Sediment transport, *Flood plains, *Arid-zone hydrology, *Geomorphology, *River systems, *Flood plain management, Flood control, Flood damage, Engineering, Legal aspects, Management planning, Bank erosion, Case studies.

Geomorphic features produced by flood processes in arid regions may be used as evidence for flood hazards. Rivers in arid environments have fundamentally different structures for temporal and spatial change than rivers in other regions. Management of flood hazards and interpretation of geomorphic evidence of flood conditions in dry regions are faulty because these differences have yet to be adequately accounted for by geomorphologic theory, engineering applications, and the law, endeavors that do not even share common basic definitions. There are three lines of endeavor likely to benefit the harmonious association between society and flood-prone areas of arid-region landscape: (1) fluvial; geomorphologic theory must be extended to account for the special properties of arid-region systems; (2) engineering applications need to account for the erodible banks and mobile beds often found in arid-region rivers; and (3) the administrative and legal system based on case law from humid regions must be receptive to alternative interpretations of evidence provided by geomorphic and hydrologic perspectives that are firmly rooted in actual rather than presupposed conditions. (See also W90-03661) (Fish-PTT)
W90-03675

FLOODPLAIN EROSION AND DEPOSITION DURING THE DECEMBER 1982 FLOODS IN SOUTHEAST MISSOURI.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
D. F. Ritter.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 243-259. 16 fig, 4 tab, 35 ref.

Descriptors: *Flood plains, *Erosion, *Deposition, Environmental effects, *Flood damage, *Geomorphology, *Alteration of flow, Sediment distribution, Flood discharge, Topography, Sand, Gravel, Flow velocity, Flood stages, Bridge failure, Sedimentary structures, Missouri.

The December 1982 floods on rivers in southeast Missouri received national attention because of the environmental problems created at Times Beach, Missouri. However, alteration of flood plains by geomorphic and sedimentologic processes operating during these rare large floods are equally disastrous. Flood plain damage was widespread and varied in magnitude from minor changes to significant alteration of the flood plain topography and surface materials. Overbank deposition of sand and gravel (as either lobate or sheetlike forms) occurred on some flood plains, as well as concomitant vertical erosion into other flood plain surfaces. At one site on the Gasconade River an enormous lobe of sand and gravel, having two distinct sublobes composed of primarily sand or gravel, was placed on the flood plain surface. Each sublobe is marked by bedforms indicating current velocities during various stages of the flood. Bridge supports adjacent to every major river in the flood area experienced damage. (See also W90-03661) (Fish-PTT)
W90-03676

GEOMORPHIC RESPONSE OF STREAMS TO FLOODS IN THE GLACIATED TERRAIN OF SOUTHERN NEW ENGLAND.
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
P. C. Patton.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 261-277. 15 fig, 28 ref.

Descriptors: *Floods, *Geomorphology, *Glaciohydrology, *Streamflow, *Connecticut, *Massachusetts, *Rhode Island, *Glacial streams, *Channel morphology, Valleys, Sediments, Sedimentology, Geologic control, Physiographic provinces, Catchment areas, Flood plains, Bedrock, Alluvial rivers, Physical control, Flood discharge, Sedimentary structures, Paleohydrology, Historic floods.

The variation in geology, physiography, and hydrology make southern New England (Connecticut, Rhode Island, and Massachusetts) an instructive region in which to evaluate geomorphic responses of streams to large floods. The inherited glacial landscape has had a profound effect on the hydrology and geomorphology of modern drainage basins. Channel morphology and pattern are

partly controlled by valley gradient and sediment type, and these are directly related to the glacial topography and sedimentology. Thus, the degree to which floods permanently affect the morphology of channels and flood plains in this region is partly a function of these pre-existing conditions. It is useful to compare the flood response of bedrock-controlled streams in highland areas with alluvial rivers in adjacent lowlands in order to determine the physical factors that control stream response to large floods. In the highland drainages flood plain surfaces demonstrate that sedimentation during floods is an important process in constructing the fluvial landforms along these rivers. On streams in lowland regions the response to floods is fundamentally different from that described for the highland drainages: erosion during rare floods, except where unusual hydraulic conditions exist, is not great. However, in selected localities, slackwater deposits may accumulate to enough thickness to remain recognizable for several thousand years. Some geomorphic traces of catastrophic events and stratigraphic evidence can be used to evaluate the paleoflood hydrology of streams in this region. (See also W90-03661) (Fish-PTT)
W90-03677

CLIMATIC INFLUENCE ON UPPER MISSISSIPPI VALLEY FLOODS.
Wisconsin Univ.-Madison. Dept. of Geography.
J. C. Knox.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 279-300. 9 fig, 6 tab, 43 ref. National Science Foundation Grant EAR-8306171.

Descriptors: *Climatology, *Flood frequency, *Historic floods, *Mississippi River, *Paleoclimatology, Streamflow, Seasonal distribution, Ecological distribution, River basins, Hardwood, Prairies, Snowmelt, Rainfall, Statistical analysis, Annual floods.

Historical streamflow records show that climatic change is a probable cause of changes in the seasonal concentration of floods during historical time. Throughout the Holocene a relatively steep climatic gradient has occurred across the Upper Mississippi River basin and it is associated with a major ecotone separating mixed hardwood forest to the northeast from prairie to the southwest. Natural floods in the Upper Mississippi Valley result from snowmelt, excessive rainfall, and various combinations of snowmelt and rainfall. Nearly 75% of all floods occur during the months of March and July. Statistical analyses show that magnitudes of annual maximum floods correlate best with magnitudes of winter snow depth and early summer rainfall. The magnitudes of floods in the Upper Mississippi Valley reflect their season occurrence. Short-term changes in flood seasonality suggest that the mean and variance of flood series often do not remain stationary as the time scale lengthens. Long-term Holocene proxy records of high-frequency floods, reconstructed from dimensions of relict stream channels, also indicate nonstationarity of the mean and variance of flood series. The magnitudes and frequencies of floods in the Upper Mississippi Valley show nonrandom behavior during historical and Holocene (postglacial) time. Correlation of flood characteristics with records of historical climate and with fossil pollen indicates that climatic change is the principal cause of the nonrandom behavior. The strong association of flood magnitudes with the amount of winter snowfall and the amount of early summer rainfall indicates that annual maximum and most large floods tend to respond best to the direct effects of climatic activity. (See also W90-03661) (Fish-PTT)
W90-03678

LARGE FLOODS AS GEOMORPHIC EVENTS IN THE HUMID TROPICS.
National Univ. of Singapore. Dept. of Geography.
A. Gupta.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 301-315. 9 fig, 4 tab, 49 ref.

Descriptors: *Geomorphology, *Floods, *Humid areas, *Tropical regions, *Denudation, *Channeling, *Terracing, Storms, Erosion rates, River systems, Historic floods, Channel morphology, Sedimentation, Flood plains, Gravel, Flood frequency, Levees, Vegetation effects, Particle size, Valleys, Physiographic balance, Case studies, Regional floods.

The frequency of high-magnitude formative events is apparently high for humid tropical regions. This attributes considerable importance to the role played by high-magnitude episodic events in tropical geomorphology, especially as denudation caused by a major storm in montane wet tropics may approach the mean annual erosional rate. Periodic occurrences of large floods in river valleys resulting from episodic meteorological events occur on a regular frequency of several years. When such flood history is combined with a supply of plentiful coarse sediment to the flooded channels, the streams are typified by certain channel forms and sedimentation pattern: (1) channel widening, (2) bar erosion and chute formation, (3) flood plain scouring, (4) increase in competence, (5) coarse gravel deposition in channel, (6) transverse gravel waves and bars, (7) flood plain deposition, (8) terrace formation, (9) levee formation in coarse material, and (10) vegetation destruction. The prominence of the persisting forms will be higher in areas of high relief and coarser valley sediment. There are at least two instances where the flood-prone tropical rivers differ from the standard model; the physiographic manifestations of such behaviors are one or more of a given list of diagnostic features found in many rivers of the humid tropics indicative of the occurrence of large floods at the interval of several years. A large number of case studies on rivers of this type are required at present to determine whether such features are at least regional in character and whether the list is truly diagnostic. (See also W90-03661) (Fish-PTT)
W90-03679

PALEOFLUVIAL ESTIMATES FROM DIMENSIONS OF FORMER CHANNELS AND MEANDERS.
Geological Survey, Denver, CO.
G. P. Williams.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 321-334. 4 tab, 72 ref.

Descriptors: *Geomorphology, *Paleohydrology, *Fluvial sediments, *Channel morphology, *Flood forecasting, Estimating, Meanders, Flood channels, Cross-sections, Catchment areas, Bed load, Sediment transport, Theoretical analysis.

Fluvial paleohydrology deals with the study of characteristics of prehistoric rivers and their channels, important for understanding the past, for evaluating past and present trends, and possibly for predicting the future. Paleochannels most commonly appear in the form of exposed cross-sections, abandoned channels on the earth's surface, and (rarely) exhumed channels. Based on such exposures, paleofluvial estimates can be made from (1) paleochannel bed sediments combined with sediment transport concepts, (2) paleochannel cross-section features, (3) paleochannel planform properties, and (4) paleodrainage basin features. A paleofluvial variable in some instances can be measured directly; in other instances it must be estimated from established morphologic or hydraulic relations; and in still other instances, its value cannot be reconstructed at all. Established relations that are of practical use in nearly all cases are empirical; theoretical and semitheoretical relations generally have not yet been sufficiently tested. Two paleofluvial problems in need of further research are how to determine the pattern of nonmeandering former streams and whether a paleostream was perennial or not. (See also W90-03661) (Fish-PTT)
W90-03680

PLANT ECOLOGICAL ASPECTS OF FLOOD GEOMORPHOLOGY AND PALEOFLOOD HISTORY.
Geological Survey, Nashville, TN.
C. R. Hupp.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 335-356. 21 fig, 5 tab, 92 ref.

Descriptors: *Historic floods, *Geomorphology, *Plant populations, *Vegetation effects, *Flood forecasting, Flood frequency, Dendrochronology, Bottomland, Tolerance, Plant morphology, Flow duration, Flood stages.

The magnitude, frequency, and duration of flooding can limit or influence most aspects of vegetation life history. Furthermore, infrequent floods leave long-term evidence of their passage via dendrogeomorphic features on bottomlands. Floods have two long-term effect on bottomland woody vegetation: (1) periodic floods of varying magnitude affect vegetation patterns, including creating 'new' areas such as point bars for vegetation establishment such that suites of bottomland species with varying tolerances to flooding develop as bands parallel to the stream channel; and (2) infrequent floods damage the bottomland plants such that their growth form reveals the effects as outwardly evident stem deformations or as anomalous growth patterns in their serial tree ring sequence (typically both). Analyses of bottomland vegetation yield useful information concerning flow duration and the magnitude and frequency of large floods. Reliable prediction of infrequent hydrologic events is critical where high flood stages may be destructive to human interests. (See also W90-03661) (Fish-PTT)
W90-03681

PALEOFLOOD ANALYSIS USING SLACKWATER DEPOSITS.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
R. C. Kochel, and V. R. Baker.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 357-376. 18 fig, 1 tab, 48 ref. NSF Surficial Processes Program Grants EAR 77-23025, EAR-8119981, EAR-8229982, EAR-8100391, and EAR-8300183.

Descriptors: *Historic floods, *Sedimentation, *Deposition, *Low flow, *Paleohydrology, Flood discharge, Flood frequency, Flood peak, Gravel, Sediment transport, Tributaries, Alluvial fans, Flood plains, Vegetation, Sedimentation rates, Flow velocity, Particle size, Bedrock, Fluvial sediments, Mineralogy, Sedimentology, Flumes, Model studies, Field tests.

Paleohydrologists have adopted two general approaches in the reconstruction of ancient flow histories of rivers: mean discharge paleohydrologic estimations and paleoflood analysis. Characterization of the magnitude and frequency of exceptionally large floods involves utilization of a variety of techniques for estimating paleoflood peak discharge: (1) indices of flow strength derived from studies of flood-transported gravel and boulders, (2) erosion of tributary debris fans, (3) flood plain vegetation, and (4) slackwater sediments. The slackwater sediment approach may provide the most abundant and accurate source of data for determining the recent geologic history of multiple large flood events in a river basin. Slackwater deposits are relatively fine-grained flood sediments deposited in flood plain areas that are sheltered from high-velocity flood flows; slackwater sedimentation is the dominant form of fine-grained flood sedimentation in narrow, deep bedrock fluvial systems, with tributary mouth deposits the most common. Mainstream floods can be distinguished from tributary floods using observations of the mineralogy and sedimentology of the deposits. Continued flume studies and quantitative field observations of slackwater sediments are needed to refine the relationships between the following: (1) peak stage and slackwater sediment stage, (2) peak discharge and slackwater sediment thickness, and (3) peak discharge and slackwater sediment grain size. Promising trends have resulted from preliminary flume experiments, some of which led to a better understanding of field observations. (See also W90-03661) (Fish-PTT)
W90-03682

EXTENDING STREAM RECORDS WITH SLACKWATER PALEOFLOOD HYDROLOGY: EXAMPLES FROM WEST TEXAS.

Southern Illinois Univ. at Carbondale. Dept. of Geology.
R. C. Kochel.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 377-391. 13 fig, 6 tab, 28 ref. National Science Foundation Grant EAR 77-23025.

Descriptors: *Stream profiles, *Low flow, *Paleohydrology, *Historic floods, *Flood frequency, Flood forecasting, Engineering, Design standards, Flood plains, Flood discharge, Flood frequency, Flood damage, Construction costs, Maintenance costs, Bedrock, Semiarid lands, Flashy streams, Flood control, Gaging, Texas.

Conventional statistical approaches for estimating the recurrence intervals of floods become less reliable with increasing flood return interval. Significant engineering design problems result from the variety of interpretations that can be made from rivers with large flood outliers. Underestimation of flood discharge and frequency will result in frequent damage and repair costs. Ideally, the design of hydrologic structures should target within the optimum zone where minimal initial construction costs and maintenance costs would occur, thereby requiring accurate estimates of flood frequency and magnitude. Slackwater paleoflood techniques can extend flood frequency records of large floods over thousands of years. These studies are most easily done in semiarid rivers where bedrock channels are common and where conventional techniques have difficulties with outliers in these flashy rivers. An application of paleohydrologic techniques has been made to the interpretation of flood frequency in southwest Texas. This study indicated that paleohydrologic estimates of flood discharge and frequency contained errors of less than 20%. Paleohydrologic estimation is required to obtain good estimates of recurrence intervals of floods whose return period significantly exceeds the period of gaging observations. Paleohydrologic investigations such as the slackwater technique can be done rapidly and inexpensively compared to the costs of constructing major flood control measures. (See also W90-03661) (Fish-PTT)
W90-03683

HYDRAULIC MODELING FOR PALEOFLOOD ANALYSIS.
Arizona Univ., Tucson. Dept. of Geosciences.
J. E. O'Connor, and R. H. Webb.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 393-402. 7 fig, 1 tab, 24 ref.

Descriptors: *Flood forecasting, *Historic floods, *Paleohydrology, *Hydraulic models, *Flood frequency, River systems, Geologic history, Flood stages, Flood discharge, Flow velocity, Computer models, Backwater, Water surface profiles, Energy loss, Channel morphology, Flow resistance, Geomorphology.

Studies of prehistoric floods (paleofloods) have proven to be effective in determining flood frequency and magnitude relationships for certain types of fluvial systems. The analysis of geologic evidence for paleoflood stages is one technique of paleoflood analysis that has shown considerable utility. A key element in paleoflood analysis is the transformation of stage information into accurate discharge estimates. Computer routines for step-backwater water surface elevation calculations, designed primarily for flood plain hazard analysis, can be utilized to increase the accuracy of paleoflood discharge determinations. These models are an improvement over previously used paleoflood discharge determination methods in that they more accurately account for flow energy losses experienced by discharges in natural channels. Water surface profiles generated by step-backwater routines are primarily dependent on the modeled discharge, the channel geometry, and, to a minor extent, the flow resistance elements. Computed water surface profiles can be matched to paleoflood water surface profiles defined independently by geologic evidence to determine paleoflood discharges and flow conditions. Best results are achieved for hydraulically simple reaches in stable channel systems that contain several representative paleoflood high-water indicators. Hydraulic flow modeling can also provide insights into large-discharge flow hydraulics, information that can enhance an understanding of flood geomorphology. (See also W90-03661) (Fish-PTT)
W90-03684

PALEOHYDROLOGIC RECONSTRUCTION OF FLOOD FREQUENCY ON THE ESCALANTE RIVER, SOUTH-CENTRAL UTAH.
Geological Survey, Tucson, AZ.
R. H. Webb, J. E. O'Connor, and V. R. Baker.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 403-418. 9 fig, 5 tab, 24 ref. NSF Grants EAR-81-19981 and EAR-83-00183.

Descriptors: *Paleohydrology, *Flood discharge, *Escalante River, *Flood frequency, *Historic floods, Arid zone, Semiarid lands, Gaging, Flood damage, Frequency analysis, Rainfall intensity, Error analysis, Dating, Utah.

One of the most important problems in the hydrology of the southwestern United States, and in other arid and semiarid regions of the world, is the estimation of flood frequency at ungaged sites or sites with short gaging records. Frequent damage from large floods that greatly exceed the 100-year flood underscores the need for improved flood frequency analysis in this region of sporadic but occasionally intense rainfall. The Escalante River in south-central Utah provides an excellent setting for the use of paleohydrologic methods to reconstruct flood frequency. Flood deposits were used to reconstruct a history of large floods for the last 2100 years. Incorporation of paleoflood information in flood frequency analysis involves a synthesis of dates of events and historic flood discharges, each of which involves some error or uncertainty in determination, with a systematic record. The date of events, or more importantly the period of record encompassing the events, has a marked influence on flood frequency analysis, because of the considerable uncertainty in dating methods. Paleoflood research would benefit from future research on dating techniques and an error analysis of paleoflood discharge calculations. (See also W90-03661) (Fish-PTT)
W90-03685

GEOMORPHOLOGIC CONTRIBUTIONS TO FLOOD CONTROL PLANNING.
Washington Univ., Seattle. Dept. of Geological Sciences.
T. Dunne.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 421-438. 10 fig, 1 tab, 78 ref.

Descriptors: *Geomorphology, *Flood control, *Flood plain management, Floodwater, Channel morphology, Sediment control, Flood damage, Warning systems, Reservoirs, Channel improvement, Diversion channels, Flood-control storage, Land management, Soil conservation, Water conservation, Land use, Flood plains, Sedimentation, Stable channels, River basins.

Fluvial geomorphology can play a more extensive role in flood control planning than is commonly realized. The most useful applications are those that recognize the relationships between the control of floodwater and the control of sediment and of channel form and activity. The methods most commonly employed for the reduction of flood damage are: flood warning and emergency action, impoundments, channel alteration and stabilization, diversion and storage of floodwaters above and below ground, land management for soil and water conservation, and control of land use on flood plains. Geomorphology can contribute to the choice and design of these strategies. Geomorphologic studies are also valuable for extending information on flood magnitudes, sedimentation, and channel stability over long periods of time and between river basins. Since mathematical modeling of these phenomena is still relatively crude and unreliable, geomorphology is the only means of providing the required historical background for flood and sediment control. (See also W90-03661) (Fish-PTT)
W90-03686

FLOODS FROM DAM FAILURES.
Cascades Volcano Observatory, Vancouver, WA.
J. E. Costa.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 439-463. 15 fig, 7 tab, 112 ref.

Descriptors: *Geomorphology, *Dam failure, *Floods, *Sediment discharge, *Flood damage, *Flood-control storage, *Paleohydrology, Flood discharge, Snowmelt, Rainfall, Accelerated erosion, Sediment transport, Deposition, Channel morphology, Valleys, Dam design, Channel scour, Flood peak, Regression analysis.

Floods resulting from dam failures usually are much larger than those originating from snowmelt or rainfall. The sudden release of large quantities of stored water from a breached dam can cause great destruction to property and potential loss of life downstream. Tremendous quantities of sediment and debris eroded, transported, and deposited downstream can cause significant modifications to channels and valley morphology. Dams can generally be classified as either constructed or natural (jokulhlaups, morainal, volcanic, and landslide). The diversity of dam types, failure mechanisms, and down-valley sediments and morphology make the prediction of channel changes, scour, and deposition speculative. For rapid prediction purposes when loss of life or property is involved, a conservative peak discharge estimate based on envelope curves developed from historic dam failures can be made from knowledge of dam height and volume using envelope curve equations. For reconstructing past flood peaks from dam failures for paleohydrological or sedimentological investigations, regression equations with peak discharge as the dependent variable probably provide a reasonable estimations if dam height and volume of stored water are known. Dam height is the best independent variable to estimate peak discharge for constructed dams. Dam factor (height multiplied by volume) is the best independent variable for estimating flood peaks from landslide and glacial dams. For all kinds of dams, dam factor has a lower overall average standard error, and is an approximate measure of the energy expended at the dam at time of failure. (See also W90-03661) (Fish-PTT)
W90-03687

TUSCON, ARIZONA, FLOOD OF OCTOBER 1983.
Arizona Univ., Tucson. Dept. of Geosciences.
P. L. Kresan.
IN: Flood Geomorphology. John Wiley & Sons, New York. 1988. p 465-489. 21 fig, 1 tab, 48 ref.

Descriptors: *Sediment transport, *Flood plain management, *Arizona, *Alluvial channels, *Geomorphology, Hydrologic aspects, Flow measurement, Flood damage, Channel erosion, Flow duration, Structural engineering, Soil cement, Bank erosion, Semiarid lands, Flood discharge, Estimating, Historic floods, Flood peak, Catchment areas, Channeling, Land management.

Flood experience in Tuscon, Arizona, shows that the dynamic nature of alluvial channels in the semiarid southwestern United States has important implications for flood management policy. The potential for dramatic changes in geomorphic and hydrologic characteristics of alluvial channels, in response to a single flow event, must be considered in establishing procedures for flood hazard evaluation. Erosion of channel banks represents a significant hazard for both large floods and for lower magnitude flows of long duration. Structural works, such as soil-cemented bank protection, may aggravate bank erosion along unprotected reaches immediately downstream. Alluvial channels in semiarid regions must be treated as total systems. Delineation of flood-prone land and the design of structures to mitigate flood hazards are predicted on estimates of the magnitude of discharge probable over a reasonable period of time. Historical documentation of changes in land use and channel characteristics along the Santa Cruz River, coupled with the flow record, substantiate a nonstationary mean. Given the complex behavior of alluvial channels, the uncertainty in estimating the

magnitude of the peak discharge likely to occur over a given period of time, the fact that flood peaks change and usually increase as land in the drainage basin is developed, and the costs and pitfalls of structural solutions (such as channelization and bank protection), the wisest approach to land management along alluvial river channels is to maintain natural conditions by discouraging development in the geomorphic flood plain. (See also W90-03661) (Fish-PTT)
W90-03688

HISTORICAL CHANGE OF LARGE ALLUVIAL RIVERS: WESTERN EUROPE.
John Wiley & Sons, New York. 1989. Edited by G.E. Petts, H. Moeller and A.L. Roux. 355p.

Descriptors: *Geomorphology, *Paleohydrology, *Alluvial rivers, *History, *Water resources development, Hydrologic data collections, Environmental engineering, Environmental effects, River training, Engineering, Case studies, Maps, Channel morphology, Channel improvement, Geochemistry, Flood plains, Pollution load, Alluvium, Fish, Fisheries, River basin development, Europe.

Recent decades have witnessed a rapid growth in man's understanding of environmental changes over the 10,000-15,000 year timescale and in the 10-50 year timescale. Substantial efforts have been made to link space and time but greater effort is needed to consider changes over the historical timescale of 100-500 years--the period of intensifying human impact culminating in the creation of truly manmade rivers. The synthesis of information from a wide range of sources has enabled general statements on the history of the large alluvial rivers of western Europe to be made. Some of these statements have been compiled into a book which examines the sequence of early river engineering works; cartographic data analyses and applications to channel change; a French case study; the use of geochemical analyses and flood plain stratigraphy in deriving pollution histories; paleoecological methods using fossil invertebrates from alluvial sediments; a case study of the Lower Rhine; reconstruction of fish faunas; historical development of fisheries of the Elbe, Douro, and Ebro; and the variability of historical models of river development as applied to the Garonne, Meuse, Weser, and Rhone rivers. This book marks the first step in the development of a European Network of Scientific Cooperation for the improved management of large rivers, ideally encouraging and advancing the historical analysis of rivers not only in western Europe but worldwide. Such studies will contribute to more rational approaches to river management, to further resource development and to better conservation practice. (See W90-03690 thru W90-03707) (Fish-PTT)
W90-03689

HISTORICAL ANALYSIS OF FLUVIAL HYDROSYSTEMS.
Loughborough Univ. of Technology (England). Dept. of Geography.
G. Petts.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 1-18. 3 fig, 2 tab, 63 ref.

Descriptors: *Geomorphology, *Paleohydrology, *River basin development, *History, *Water resources development, *River regulations, Hydrologic data collections, Environmental effects, Flood plains, Natural resources, Conservation, Research priorities, Scientific personnel, Europe.

Knowledge of environmental change resulting from our exploitation of land and water resources over historic timescales is necessary to improve river regulation strategies; to achieve sustainable resource development; and to advance environmental conservation. During the 1980s there have been three major shifts in river regulation: (1) a change from river development to river management; (2) a move by scientists to tackle problems of large rivers; and (3) a development of multidisciplinary approaches to both research and management. In Europe, all three themes are embodied within the 'European Large Alluvial Rivers Network,' formed in 1986 in response to an initiative of the Council of Europe to promote scientific and technical cooperation, and concerned with water as a natural resource and the interaction between that resource and the environment. (See also (W90-03689) (Fish-PTT)
W90-03690

IMPACT OF 18TH AND 19TH CENTURY RIVER TRAINING WORKS: THREE CASE STUDIES FROM SWITZERLAND.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
D. Vischer.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 19-40. 10 fig, 12 ref.

Descriptors: *History, *Switzerland, *River training, *Case studies, *Flood plain management, Erosion control, Mountains, Lakes, Settling basins, Flood peak, Sediment discharge, Diversion channels, Canals, Dams, Flood discharge, Hydraulic engineering.

Historically in Swiss hydraulics, nearly all the large river training enterprises and erosion abatement schemes in mountain torrents were carried out, or at least begun, in the 19th century. The training of the River Kander between 1711 and 1714 led to an impressive number of other river training enterprises in the 19th century. Examples of these later works include the training of the River Linth and of the rivers at the foot of the Jura Mountains. In all three projects, one or more natural lakes were integrated into the schemes as retention basins for peak runoff and sediments. The forerunner of Swiss river regulation schemes was the diversion of the River Kander through a channel into Lake Thun, involving an open cut through Strattligen Hill. At the Linth works, from 1807 onwards, the river was channeled through a canal into Lake Walensee. Lateral dam heights were chosen to provide protection against even the largest flood discharges. The outflow of the Walensee was improved and the lake surface lowered. Beginning in 1867, the River Aare was diverted into Lake Biel through a canal; the combined waters of the Aare and Zihl were drained from Lake Biel through a canal; and the upper Zihl, lower Broye, and entrance of the Emme were corrected as necessary. The fact that 70 years after completion of the first correction of the Jura waters a second one became necessary does not speak against the farsightedness of these men. Even in river engineering there is no measure which is satisfactory forever; not only do the waters themselves and the land surrounding them undergo changes, but so do the requirements of the local inhabitants. (See also (W90-03689) (Fish-PTT)
W90-03691

HYDROCLIMATIC FLUCTUATIONS OF SOME EUROPEAN RIVERS SINCE 1800.
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
For primary bibliographic entry see Field 2A.
W90-03692

HYDROLOGICAL CHANGES OF THE RHONE RIVER.
Grenoble-1 Univ. (France). Lab. de la Montagne Alpine.
H. Vivian.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 57-77. 6 fig, 4 tab, 13 ref.

Descriptors: *Rhone River, *River training, *Flood plain management, *Water supply development, *River systems, Hydrological regime, Runoff, Glacial drift, Glaciohydrology, Rainfall-runoff relationships, Flood protection, Irrigation effects, Agricultural hydrology, Hydroelectric plants, Drainage engineering, Discharge capacity, Stream discharge, France.

Major manmade changes have affected both the Rhone river (France) and its main tributaries. The most obvious of these has been the hydroelectric developments undertaken during the second half of the 20th century. Flood protection, irrigation, and agricultural land drainage schemes have accompanied these developments. The natural parameters controlling the water supply may be grouped into two categories: (1) the change in runoff pattern resulting from glacial dynamics, and (2) the change of the rainfall regime since the beginning of the century. The relative influence of natural and anthropological factors can be defined by using the method of accumulated normalized deviations; the discharge and rainfall trends are determined in order to detect any behavioral similarity or difference between the two variables. After examining the discharge data and reflecting upon the importance of the changes in the annual and monthly discharge rates of the Rhone throughout the century, and on the respective part played by natural and anthropogenic influences, four conclusions may be drawn: (1) little change occurred until 1950, thereafter anthropological influences are evident; (2) the changes to the Rhone's hydrological regime decrease rapidly downstream, and upstream from Lyon the changes are less apparent than in the Valais; (3) this downstream reduction may be explained by a switch from a simple regime to a compensated regime; and (4) for certain months there are important changes due to either a combined natural and anthropological influence (February-March-June-July-August), or else the pre-eminent action of one of these two influences. (See also (W90-03689) (Fish-PTT)
W90-03693

USE OF CARTOGRAPHIC SOURCES FOR ANALYSING RIVER CHANNEL CHANGE WITH EXAMPLES FROM BRITAIN.
Portsmouth Polytechnic (England). Dept. of Geography.
J. M. Hooke, and C. E. Redmond.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 79-93. 3 fig, 5 tab, 48 ref.

Descriptors: *Paleohydrology, *Geomorphology, *England, *Maps, *Channel morphology, *Channeling, *River forecasting, *History, Lotic environment, River training, Flood plains, Braided streams, Data interpretation, Mathematical studies.

Historical maps have the potential to provide much information on large rivers including detail of river changes. A general background on the location and timescales of changes of channel morphology is important for understanding the dynamics of lotic ecosystems. Historical studies are often used to predict future changes and behavior of a channel, and are much more likely to be valid if an historical perspective is taken rather than relying solely on contemporary observations. Information that can be derived from historical maps includes: location and distribution of instability and old channels, length of change, sinuosity, degree of braiding, distances and rates of movement, areas of movement, direction of movement, type of change, change in characteristics, and flood plain ages. A number of problems arise in using such sources, some of which are associated with the historical nature of the sources, some have to do with the style and accuracy of the maps themselves, and some are related to the methods of analysis. Maps which are of potential use in assessing channel changes along British rivers can be divided into four main groups: early manuscript maps, 'county' maps, Ordnance Survey maps, and deposited plans. The choice of method of compilation depends on the form of map availability and the compatibility of map scales as well as on the information required. Techniques for analyzing cartographic evidence of the history of river channels are grouped according to the form of material, i.e., the map itself or derived data and to the type of information required, whether qualitative or quantitative. The principles applied to British rivers may be used elsewhere. (See also (W90-03689) (Fish-PTT)
W90-03694

CARTOGRAPHY OF RIVERS IN FRANCE.
Lyon-3 Univ. (France).

J. P. Bravard, and J. Bethemont.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 95-111. 10 fig, 1 tab, 30 ref.

Descriptors: *Maps, *Hydrologic maps, *River systems, *France, *Information systems, Data collections, History, Remote sensing.

French river maps have been collected in surprising abundance. From the end of the 19th century onwards, photographs and postcards are of particular interest because they often show rivers. Inventories of available material do not exist in many cases and one need is for these to be compiled prior to a systematic research on the interaction between man and river in modern times. The interest in these maps is widely related to their accuracy, controlled with the help of various methods ranging from critical examination of texts to remote sensing analysis. Cartographic analyses are clearly a fundamental tool for historical studies of change in fluvial hydrosystems but in many areas their potential is still to be exploited. (See also (W90-03689) (Fish-PTT)
W90-03695

EVOLUTION OF THE PO RIVER: AN EXAMPLE OF THE APPLICATION OF HISTORIC MAPS.
Pavia Univ. (Italy). Dipt. di Ingegneria del Territorio.
G. Braga, and S. Gervasoni.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 113-126. 3 fig, 1 tab, 8 ref.

Descriptors: *Po River, *Italy, *Geomorphology, *History, *Maps, *Channel morphology, *River systems, River training, Aerial photography, Alluvial plains, Terrace channels, Terracing, Dating, Geologic control, Tectonics, River beds, Migration.

The geomorphological evolution of the River Po (Italy) over the last few centuries may be determined through examination of a reach between the confluences of the Rivers Sesia and Adda. Changes of the river channel in response to natural and artificial influences have been analyzed by using three sources of data: (1) aerial photographs of the present-day river and alluvial plain have been used to map the major geomorphological elements, such as terrace scarps, abandoned channels and bars; (2) historical data sources such as maps and documents were used to date the abandoned channels; (3) analyses of the natural events that have influenced morphological evolution and the spatial pattern of landforms allow the consideration of the effects of geological and neotectonic activity to be evaluated. The analysis of channel patterns based upon historic maps has revealed two general types of change: (1) the sudden and dramatic change in the course of the old Sesia river occurred long before the 16th century (possibly related to neotectonic movement that is still active; and (2) the more recent effects of the neotectonic movements are causing the raising of the external margin of the Appenine chain, and the northward migration of the Po river bed. The synthesis of this kind of historical and geomorphological survey allows consideration of the hydrogeomorphology of the studied reach of the Po river channel in order to assess future trends. (See also (W90-03689) (Fish-PTT)
W90-03696

EVIDENCE FOR HISTORICAL HEAVY METAL POLLUTION IN FLOODPLAIN SOILS: THE MEUSE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 5B.
W90-03697

PALEOECOLOGICAL ANALYSES OF LARGE RIVERS: SOME PRINCIPLES AND METHODS.
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
C. Amoros, and G. Van Urk.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 143-165. 10 fig, 70 ref.

Descriptors: *Rhone River, *Rhine River, *Paleohydrology, *Ecological effects, *History, *Ecosystem, *River systems, Palynology, Silt, Macrophytes, Algae, Alluvial plains, Cutoffs, Midges, Backwater, Radioactive dating, Maps, Deposition, Succession.

The aim of paleoecological studies is the reconstruction of past ecological conditions and historical changes of ecosystems, using remains of plants and animals preserved in fine sediments. Data are required urgently to describe the historical dynamics of large rivers and this is especially true in a European context. For an insight into ecosystem functioning in the past, studies of a broad spectrum of organisms, including algae and macrophytes, are essential, but studies of this kind are still in a preliminary phase for the Rhone and Rhine Rivers (Germany). Palynology addresses chiefly the terrestrial part of the alluvial flood plain; sediments from cutoff channels constitute a convenient matrix for preserving the pollen in chronological sequence. Cladoceran and chironomid remains are abundant in unreworked sediments from backwaters and cutoff channels of large rivers. These taxa are very diversified and can afford adequate information about the functioning and the development of the aquatic ecosystems before and after human impacts. Lead-210 dating is possible when the allocthonous component in the sediment is negligible but cartographic sources are most widely applicable. Generally historical data and granulometric analyses of the sediments provide adequate information on the period and the conditions of deposition. Where it is possible, comparisons of the paleoecological results (diachronic analyses) with the community composition of present-day ecosystems occurring at different stages of succession (synchronic analyses), lead more rapidly to an understanding of the process involved in ecosystem development. (See also (W90-03689) (Fish-PTT)
W90-03698

LOWER RHINE GEOMORPHOLOGICAL CHANGES.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
G. Van Urk, and H. Smit.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 167-182. 6 fig, 2 tab, 35 ref.

Descriptors: *River training, *Water pollution effects, *Rhine River, *Geomorphology, *Channel morphology, *Ecological effects, *River basin development, Engineering, Dikes, Levees, Embankments, Channeling, History, Maps, River systems, Navigation, Channel improvement, Organic matter, Vegetation, Pollution load, Food chains, Benthic environment, Sand, Gravel, Sedimentation, The Netherlands.

Human activity disrupted the natural sequence of channel change on the Lower Rhine (Netherlands). It is possible that river engineering, such as dikes, levees, embankments, and channeling, has had morphological and ecological consequences. Interest in the ecological consequences of river engineering and in the need to minimize damage did not arise until recently, when the restoration of the Rhine became an important issue. A study of river maps made since 1829, analyses of sediment cores from the river, and ecological investigations carried out in the Waal river valley show that in the Lower Rhine channel fixation and constriction during the 19th century facilitated cultivation of the flood plain, thus allowing for the removal of the remnants of the natural vegetation. It may be assumed that this caused a drastic reduction of supply of organic matter from the flood plain to the main river. Physical constraints and a shortage of food supply limit benthic communities in the sand and gravel substrates, whereas pollutants have strongly impacted the benthos of the sedimentation zone. Even if the pollution load of the Rhine were to decrease to negligible amounts, the existing channel morphology would prevent the restoration of a diverse river ecosystem. A balance needs to be found between safety demands for the dikes, navigation requirements and ecological management of the river basin. (See also (W90-03689) (Fish-PTT)
W90-03699

LOWER RHINE: PALAEOECOLOGICAL ANALYSIS.
Klink Hydrobiological Consultants, Wageningen (Netherlands).
A. Klink.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 183-201. 9 fig, 1 tab, 46 ref, append.

Descriptors: *Rhine River, *Aquatic insects, *Paleohydrology, *Geomorphology, *Ecological effects, *Flood plains, *Ecosystems, Stratigraphy, Water pollution effects, Sediment contamination, Maps, Dating, History, Cores, Water quality, Insects, Species composition, Water temperature, Heavy metals, Sediment distribution, The Netherlands.

Paleoecological river research is being performed in the Netherlands. The first flood plain samples from the River Rhine were analyzed in 1983 and since then, progressively, biological evidence has been building up concerning the history of the river. The lack of a reliable dating method of river sediment cores was a major problem, but can be partly overcome by collecting flood plain deposits, with minimum ages determined from old maps. As a consequence of large-scale chemical and physical changes which have taken place in the Rhine, the insect fauna of the river has changed completely. Eighty to one hundred insect taxa have disappeared from the river over the last few centuries. Three important changes of individual taxa are: (1) the distribution of species with a southern distribution possibly caused by the long-term rise in water temperature; (2) a positive relationship between the deformities of headcapsules and the heavy metal content of the river sediment; and (3) the decline and extinction of Simuliidae, once abundant, over the last few centuries. The changes observed in the Rhine by means of sediment analyses still stand fairly isolated, since no direct links can be made with causal factors. Research needs to focus on establishing these links. (See also (W90-03689) (Fish-PTT)
W90-03700

CHANGES IN FISH STOCKS AND FISHERIES: THE LOWER ELBE RIVER.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
H. Moller.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 203-220. 2 fig, 6 tab, 80 ref.

Descriptors: *River training, *Elbe River, *Fisheries, *History, *River regulations, *Commercial fishing, Parasites, Pesticides, History, Data interpretation, Fishing gear, Nets, Rivers, Shallow water, Eel, Water quality, Tributaries, Waste management, Czechoslovakia, Germany.

The large rivers of western Europe once sustained important fish stocks and supported valuable fisheries. Historic documentary data sources may be used to assess changes of fish stocks and fisheries of the lower Elbe River (Czechoslovakia and Germany). Conclusions may be drawn from comparisons of published as well as unpublished historical data with results from two recently-made surveys on fish biology in the lower Elbe River in 1984 and 1988. Quantitative data presented are restricted to results from catches of anchor nets, the most important fishing gear on the river today. The lower Elbe has suffered far less from stream regulation than most other large European rivers. Since the beginning of this century, the Wadden area between Cuxhaven and Hamburg has been reduced by 11% and the shallow water area by 26%. However, serious alterations have taken place especially in the most important nursery grounds for Elbe fishes between Finkenwerder and the

Schwinge estuary, where more than half the shallow water area has been lost. Despite these disadvantages, the present situation maintains a rich fish population which sustains a profitable business for the remaining eight anchor net vessels, although the most frequent species are of no, or only of low, commercial value. The greatest threat to fisheries today is not seen in any pollution-induced decline of fish stocks, but in the occurrence of pesticides and parasites in the fish, especially in eel. Encouraging progress has been achieved towards a more acceptable water quality by the restoration of several tributary rivers and by a considerable reduction of waste input from the city of Hamburg and several industrial areas. (See also (W90-03689) (Fish-PTT)
W90-03701

HISTORICAL CHANGES OF THE GARONNE RIVER, SOUTHERN FRANCE.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 4A.
W90-03704

RECENT HISTORICAL CHANGES ON THE BELGIAN MEUSE.
Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium). Unite d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 6G.
W90-03705

HISTORICAL CHANGES OF THE RIVER WESER.
Wasserwirtschaftsamt Bremen (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W90-03706

ECOLOGICAL CHANGES OF THE FRENCH UPPER RHONE RIVER SINCE 1750.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 4A.
W90-03707

SYSTEMS APPROACH TO WATER QUALITY MANAGEMENT DURING DROUGHT PERIODS IN THE CUMBERLAND RIVER BASIN.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W90-03719

ANALYSIS OF 1987 FLOOD OF WEST MEMPHIS, ARKANSAS.
Memphis State Univ., TN. Dept. of Geography and Planning.
H. Kung, and J. R. Richardson.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 63-65. 2 tab, 6 ref.

Descriptors: *Drainage canals, *Flood control, *Arkansas, *Floods, *Flood basins, *Drainage area, *Storm runoff, Rainfall-runoff relationships, Soil moisture retention, Soil water, Flood damage, Bayous, Topsoil, Drainage, Drainage patterns, Flood protection, Clays, Cost analysis, Ditches.

The flooding that occurred in West Memphis, Arkansas, in December 1987, was an unusual phenomenon due to its magnitude and extent. The nature and causes of this flood are reviewed, along with possible ways to reduce future flooding problems. Some areas flooded beyond the statistical, 500-yr boundary of 10-11 inches of rain in one event. The top soils of the area consist of plastic clayey materials which drain poorly. They have an average soil permeability of 0.11 inches per hour 2.64 inches in a 24-hr period. The topography of the area consists of elevated barriers surrounding the area to the north and east, which constrict the natural runoff of rainwater. This lack of movement in a natural drainage pattern has prompted the city of West Memphis to build ditches to assist in the drainage of water. Ten-mile and one fifteen-mile Bayous are the primary movers of drainage in the city. At the time of the flood, the bottoms of most of the major bayous in the area had several inches, if not feet, of eroded topsoil in them. A study of the Corps. of Engineers suggested the building of wider, concrete-lined drains along a 24 mile stretch of both the major bayous to end at the junction of Ten Mile Bayou and the St. Louis-San Francisco Railroad line in West Memphis. The plan was projected to cost about 22 million dollars and have a cost-effective benefit/cost ratio. An annual cleaning program of the city's ditches is recommended. (See also W90-03708) (Friedmann-PTT)
W90-03720

REGIONAL SKEW COEFFICIENTS FOR FLOOD-FREQUENCY ANALYSIS OF MISSISSIPPI STREAMS.
Geological Survey, Jackson, MS. Mississippi District.
M. N. Landers.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 66-70. 2 fig, 2 tab, 5 ref.

Descriptors: *Streamflow, *Statistical analysis, *Flood frequency, *Flood forecasting, *Mississippi, *Flood recurrence interval, *Flood peak, *Flood data, Flood crest, Statistical methods, Data collections, Flood plain management, Estimating.

An estimate of population skew is required to estimate flood-frequency curves using the Pearson type III distribution as recommended by the Interagency Advisory Committee on Water Data (1982). Population skew coefficients may be estimated from the error weighted average of the sample skew and regional skew coefficient . Weighted estimating methods for regional skew coefficients are suggested, because the sampling error of station skew coefficients varies with the record lengths of the stations. A weighted grid isoline mapping method has been used in this analysis to estimate regional skew coefficients for flood-frequency analyses of Mississippi streams. The weighted grid mapping method was shown to be more accurate than the IACWD skew map in two of three homogeneous skew regions in the state, based on a comparison of the MPRESS and MSE of the two estimators. Flood-frequency information forms an essential basis for managing development in flood plains. The accuracy of flood-frequency estimates from records of annual peak flow is improved by correcting for bias in sample skew coefficients and by using weighted regional skew estimating methods. (See also W90-03708) (Author's abstract)
W90-03721

CHANNEL STABILITY OF SELECTED STREAMS IN NORTHERN MISSISSIPPI.
Geological Survey, Jackson, MS.
For primary bibliographic entry see Field 2J.
W90-03726

EVALUATION OF INSTREAM FLOW REQUIREMENTS OF FISHES IN THE OZARK AND OUACHITA NATIONAL FORESTS, ARKANSAS.
Forest Service, Hot Springs, AK.
For primary bibliographic entry see Field 2H.
W90-03727

SUITABILITY CRITERIA FOR ASSESSMENT OF INSTREAM FLOW NEEDS OF FISH.
National Ecology Research Center, Fort Collins, Co.
For primary bibliographic entry see Field 2H.
W90-03729

HYDROLOGIC SYSTEMS, VOLUME I: RAINFALL-RUNOFF MODELING.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh.
Prentice Hall, Englewood Cliffs, New Jersey. 1988. 480p.

Descriptors: *Rainfall-runoff relationships, *Hydrologic models, *Model studies, *Mathematical models, Mathematical equations, Linear analysis, Watersheds, Runoff.

The subject of hydrologic systems has expanded greatly in recent years both in variety of techniques and diversity of applications. This book, an outgrowth of lecture notes prepared for courses on hydrologic modeling, is divided into three parts. The first part, encompassing seven chapters, presents preliminaries perceived to be background information essential for developing of hydrologic models. It constitutes the foundation upon which rests the development of subsequent parts: the philosophy of systems approach, definitions and concepts; types of hydrologic problems and the models to be developed to address them; elementary functions and their hydrologic responses and their applications to the development of superposition integrals; methods of moments and cumulants commonly used for estimating parameters of hydrologic models derived by applying the elementary functions or otherwise; and seven additional methods of parameter estimation, some of which are of recent origin. The second part deals with system function is derived by considering various aspects of rainfall-runoff relationship that constitute the subject matter: watershed runoff and its time characteristics; different types of mathematical models for an effective rainfall-direct runoff relationship that have been presented in hydrologic literature; both continuous-time and discrete-time linear time-invariant models; differential equations and the characteristics of rainfall-runoff systems that they exhibit as well as the relationship with conceptual models to include the continuous-time, discrete-time, linear time-invariant and linear time-varying models. The discussion is extended to nonlinear conceptual models and to nonlinear empirical models their applicability to ungaged watersheds. The third part deals with flood routing. The methods of reservoir flood routing are discussed. Linear and nonlinear as well as empirical and conceptual models are included. Methods of channel flood routing are discussed as well as linear and nonlinear, empirical and conceptual, and time-invariant and time-variant models. (Lantz-PTT)
W90-03764

EFFECTS OF CLIMATE CHANGE ON WATERSHED RUNOFF.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-03824

HIGH-RESOLUTION TWO DIMENSIONAL ADVECTIVE TRANSPORT.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 8B.
W90-03827

PRELIMINARY ANALYSIS FOR TRENDS IN SELECTED WATER QUALITY CHARACTERISTICS, POWDER RIVER, MONTANA AND WYOMING, WATER YEARS, 1952-85.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-03877

GRAVEL TRANSPORT IN THE BRAIDED WAIMAKARIRI RIVER: MECHANISMS, MEASUREMENTS AND PREDICTIONS.
Carson (M.A.) and Associates, Victoria (British Columbia).
For primary bibliographic entry see Field 2J.
W90-03903

COMPARISON OF TWO HYDROLOGIC MODELS FOR STEEPLY SLOPING FORESTED WATERSHEDS.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
A. Q. Khan, and L. E. Ormsbee.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 325-349, August 1989. 5 fig, 11 tab, 29 ref. U.S. DOI Agreements 14-08-00001-G1019 and 14-08-00001-1227 and project A-104-KY.

Descriptors: *Unit hydrographs, *Rainfall-runoff relationships, *Hydrologic models, *Forest watersheds, *Model studies, *Model testing, *Forest hydrology, Comparison studies, Catchment areas, Forests, Calibrations, Watersheds.

In an attempt to evaluate the usefulness of the unit hydrograph method to simulated the hydrologic response of steeply sloping forested watersheds, Clark's model was applied to three watersheds in West Virginia and eastern Kentucky. Using calibration, Clark's method successfully reproduced the observed storm hydrographs in these watersheds. However, when subjected to validation tests, the model failed to sustain its calibration performance. In a similar endeavor, a simple conceptual model that included a quick response macropore flow component in addition to a slow response micropore flow element was also applied to the same three watersheds. This model, called the extended kinematic storage model, is an outgrowth of Sloan and Moore's kinematic storage model. On calibration, the model predicted with reasonable accuracy the response of these watersheds. The results thus indicate that the model is capable of simulating the hydrologic response of this type of watershed. When subjected to validation tests, unlike Clark's model, the extended kinematic storage model survived the validation tests. This study suggests that the fundamental hydrologic behavior of the modeled watersheds is markedly influenced by the seasonal variations of both the surface and subsurface characteristics of the watersheds. The failure of Clark's model and the relative success of the extended kinematic storage model may illuminated the potential danger of using standard storm hydrograph models such as Clark's in watersheds where Hortonian overland flow may not be the dominant runoff mechanism. Management decisions based on conclusions from readily available but potentially flawed empirical models may expose long-term watershed planning and management to significant risk. (Author's abstract)
W90-03910

WATER TRANSFERS INTO GLACIAL DEPOSITS OF A WATERSHED IN THE GENEVA LAKE BASIN: WATER TRANSFERS IN THE UNSATURATED ZONE (ETUDE DES TRANSFERTS D'EAU A L'INTERIEUR D'UNE FORMATION MORAINIQUE DANS LE BASSIN DU LEMAN: TRANSFERTS D'EAU LA ZONE NON SATUREE).
Institut National de la Recherche Agronomique, Thonon-les-Bains (France). Centre de Recherches Geodynamiques.
S. Hamid, M. Dray, A. Ferhi, J. M. Dorioz, and M. Normand.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 369-385, August 1989. 9 fig, 21 ref. English summary.

Descriptors: *Glaciohydrology, *Aeration zone, *Soil water, *Rainfall-runoff relationships, *Snowmelt, Overland flow, Hydrographs, Discharge hydrographs, Soil profiles, Soil water retention, Unsaturated flow, Tensiometers, Catchment areas.

Isotopic and chemical studies were carried out from June 1985 to June 1986 on a small agricultural morainic water basin (0.14 sq km) to determine the different flow components. Measurements were made of precipitation, soil water content, and discharge at the outlet of the basin. Discharges varied between 6 and 53 L/s and reflected the snowy-rainy regime of the basin, which received 1036 mm during the twelve-month study. The soil humidity indicated three periods: (1) in summer, a drying period that affects a depth of 90 cm; (2) wetting during autumn that modifies the water content of only the upper 45 cm; and (3) during the winter and spring, saturation of the soil. Tensiometric measurements showed a desaturation with upward water movement during the period from September to November. Then a saturation of the whole profile occurs from November to June. The data monitoring exhibited two systems of flow movement in the soil: (1) a superficial one, which facilitates runoff or subsurface lateral movement, linked directly to precipitation; and (2) a lower system, originating outside the basin. Hydrograph separation of discharge at the outlet indicates the origin of the different flow components. When the runoff flow starts in the river bed after the dry season, it is the sandy layer that provides the major flow. Then, when the saturation level is reached, one can observe lateral subsurface flow. In some special cases (snowmelt), a pure runoff is recognizable, caused by the frozen soil. This study emphasizes the essential role played by the texture and structure contrasts of the pedologic-lithologic horizons of the fluvioglacial deposits that 'condition' the different flow components: pure runoff, and/or hypodermic movement, and/or infiltration to recharge the aquifer. (Author's abstract)
W90-03912

DYNAMICS AND SEDIMENTOLOGY OF THE DEPOSITS OF THE FLOOD IN THE LOWER STRETCH OF THE JUCAR RIVER IN OCTOBER OF 1982 (DINAMICA Y SEDIMENTOLOGIA DE LOS DEPOSITOS DE LA AVENIDA DEL RIO JUCAR EN OCTUBRE DE 1982 EN SU TRAMO BAJO).
Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
For primary bibliographic entry see Field 2J.
W90-03927

COMPARISON OF METHOD OF RESIDUALS AND CLUSTER ANALYSIS FOR FLOOD REGIONALIZATION.
Louisville Univ., KY. Dept. of Civil Engineering.
N. B. Bhaskar, and C. A. O'Connor.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 793-808, November 1989. 2 fig, 8 tab, 10 ref.

Descriptors: *Kentucky, *Floods, *Regional analysis, *Method of residuals, *Flood forecasting, *Cluster analysis, Statistics, WATSTORE.

The method of residuals was used recently by the U.S. Geological Survey (USGS) to delineate seven flood regions for the state of Kentucky. An alternative approach is to use cluster analysis in conjunction with important statistical properties of the maximum flood-peak series. Applying the FASTCLUS clustering procedure of the Statistical Analysis System, five cluster regions were identified using a similar data base to the one used by the USGS study (i.e., WATSTORE data from Kentucky). Flood regions delineated under these two methods of flood regionalization were compared by examining trends in important hydrologic characteristics within each of the regions and through a discriminant analysis based on watershed physical attributes. Results show that, although cluster regions are in no way similar to those defined by the method of residuals nor coincident with geographic boundaries, they are more distinguishable and better discriminated in terms of hydrologic characteristics controlling flood response in the USGS regions. Furthermore, standard errors associated with the regression equations relating the log-Pearson, Type-III 50-yr flood estimate to watershed physical attributes are comparable under the two methods of regionalization. (Author's abstract)
W90-03979

REMOTE SENSING AND FULLY DISTRIBUTED MODELING FOR FLOOD FORECASTING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
T. Tao, and N. Kouwen.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 809-823, November 1989. 5 fig, 3 tab, 25 ref.

Descriptors: *Remote sensing, *Flood forecasting, *Hydrologic models, Satellite technology, Mathematical models, Prediction, Runoff, Land use, Data acquisition.

The advantage of introducing Landsat-derived land-cover information into a flood-flow forecasting model was examined. Two modeling alternatives, with and without Landsat data, were applied to 10 x 10 km grid sizes. The land-cover information was derived primarily from Landsat imagery and used directly for rainfall excess estimation and runoff routing. Runoff was calculated separately for each of six land-use/land-cover classifications for each watershed element. Without Landsat data the model is a lumped-parameter model, whereas with Landsat data it is a fully distributed model. The advantage of calculating runoff for each land-use/land-cover class separately is that a watershed element can be substantially larger than a typical homogeneous hydrologic unit. The improvement in predicting flood peaks and total runoff gained by using Landsat data is at the 10% level of significance. (Author's abstract)
W90-03980

TEST OF SNOWMELT-RUNOFF MODEL FOR A MAJOR RIVER BASIN IN WESTERN HIMALAYAS.
Howard Univ., Washington, DC. Dept. of Geology and Geography.
B. Dey, V. K. Sharma, and A. Rango.
Nordic Hydrology NOHYBB, Vol. 20, No. 3, p 167-178, 1989. 5 fig, 1 tab, 11 ref.

Descriptors: *Runoff forecasting, *Himalayas, *Kabul River, *Snowmelt, *Hydrologic models, *Snowmelt-Runoff Model, Mountain streams, Temperature, Satellite technology, Remote sensing, Simulation, Data acquisition, Mathematical models.

In the Snowmelt-Runoff Model (SRM), the estimate of discharge volume is based on temperature condition in the form of degree days, which are used to melt the snowpack in the area of the basin covered by snow as observed from satellites. Precipitation input is used to add any rainfall runoff to the snowmelt component. When SRM was applied to the large, international Kabul River basin, initial simulations were much above the observed stream flow values. Close inspection revealed several problems in the application of the SRM to the Kabul Basin that were easily corrected. Foremost among the corrections was determination of an appropriate lapse rate, substitution of a more representative mean elevation for extrapolation of temperature data, and use of an automatic streamflow updating procedure. These improvements led to a simulation for 1976 that was comparable to other simulations on large, inaccessible basins. As SRM is applied to more basins similar to the Kabul River, the determination of suitable parameters for new basins will be enhanced. Additional improvements in simulations would result from installation of climate stations at the mean elevation of the basins and work to assure delivery of timely and reliable satellite snow cover data. (Author's abstract)
W90-03985

SIMPLE APPROXIMATION OF THE HYDROGRAPH DOWNSTREAM OF A FLOODED AREA.
Consiglio Nazionale delle Ricerche, Perugia (Italy). Ist. di Ricerca per la Protezione Idrogeologica nell' Italia Centrale.
C. Corradini, F. Melone, and V. P. Singh.
Nordic Hydrology NOHYBB, Vol. 20, No. 3, p 179-190, 1989. 4 fig, 3 tab, 13 ref. NSF Grant INT 84-0205.

Descriptors: *Model studies, *Italy, *Floods, *Hydrographs, *Mathematical models, *Flood routing, Outbank flow, Hydrodynamics, Runoff, Flood peak, Errors.

A simple model for estimating the hydrograph at the outlet of a reach crossing a flood-prone area was investigated. The first part of the model involves routing of the inflow hydrograph through an ideal reach with infinite vertical extension of the

walls. The second part routes the flow that determines a two-dimensional flooding (outbank flow) through a linear reservoir that has its storage coefficient linked to geometric features of the flood plain. The model was applied to various geometric configurations representative of real areas in central Italy. Its calibration and validation were carried out by comparison of the results of a diffusion hydrodynamic model. The hydrodynamic model incorporates two-dimensional overland flow and a one-dimensional open channel flow. The two models were in substantial agreement, as revealed by similar shape characteristics of the corresponding hydrographs and by the values of the peak runoff error, which were lower than 15% of the maximum outbank flow. The model's validity also was confirmed by a comparison of its results with observed outflow hydrographs. (Author's abstract)
W90-03986

NEW EXPRESSION FOR THE UNCERTAINTY OF A CURRENT METER DISCHARGE MEASUREMENT.
Danish Land Development Service, Slagelse.
For primary bibliographic entry see Field 7B.
W90-03987

RUNOFF MODELING UNDER NOISE-CORRUPTED RAINFALL CONDITIONS.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
G. G. Patry, A. Kennedy, and S. Potter.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 669-677, October 1989. 10 fig, 2 tab, 11 ref. Natural Sciences and Engineering Research Council of Canada Grant A5142.

Descriptors: *Model studies, *Runoff forecasting, *Surface runoff, *Rainfall-runoff relationships, *Hydrologic models, *Error analysis, Runoff, Noise, Statistical analysis, Stochastic models, Unit hydrographs, Probability distribution, Monte Carlo method.

Hydrological models are now routinely used in planning, design, operation and control of water resources systems. However, all models, no matter how complex, are approximations of the real world and consequently are subject to various levels of errors. The analysis of uncertainty in hydrological models can provide valuable insight into the limitations and advantages of various surface runoff models. The benefits derived from such an analysis are many: first, it provides the modeler with a direct estimate of runoff prediction error under specific rainfall conditions; second, it enables the user to analyze the tradeoffs between different rainfall-runoff models; and finally, it can provide useful information for the design of data collection systems designed to achieve a given level of performance. This paper describes the application of uncertainty analysis to rainfall-runoff modeling under noise-corrupted rainfall conditions. The statistical properties of surface runoff subject to noise-corrupted rainfall conditions are examined. Methods of analysis described include derived probability distribution, first-order analysis, and Monte Carlo simulations. The techniques are applied to linear and nonlinear runoff models, including the unit hydrograph, and the Soil Conservation Service model. (Author's abstract)
W90-04021

GLUCOSE-MINERALIZATION POTENTIAL OF EPILITHIC BACTERIA IN DIVERSE UPLAND ACID HEADSTREAMS FOLLOWING A WINTER SPATE.
Hull Univ. (England). Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W90-04073

DISTRIBUTION OF AQUATIC BRYOPHYTES IN RELATION TO WATER CHEMISTRY OF THE ACID RIVER AKAGAWA, JAPAN.
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 2H.
W90-04074

AMELIORATION OF STORM-WATER QUALITY BY A FRESHWATER ESTUARY.
Ohio Dept. of Natural Resources, Huron, OH.
For primary bibliographic entry see Field 2H.
W90-04078

DEPENDENCE OF THE RESPIRATION RATE UPON OXYGEN CONCENTRATION IN WATER FOR SOME RHEOPHILOUS MAYFLY LARVAE (EPHEMEROPTERA).
Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
For primary bibliographic entry see Field 2H.
W90-04084

MICROZOOPLANKTON GRAZING ON PHYTOPLANKTON IN THE RHODE RIVER, MARYLAND: NONLINEAR FEEDING KINETICS.
Smithsonian Environmental Research Center, Edgewater, MD.
For primary bibliographic entry see Field 2H.
W90-04113

SIMULATING EFFECT OF CHANNEL CHANGES ON STREAM INFILTRATION.
Arizona Water Resources Research Center, Tucson.
A. G. Guzman, L. G. Wilson, S. P. Neuman, and M. D. Osborn.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1631-1645, December 1989. 13 fig, 3 tab, 10 ref.

Descriptors: *Surface-groundwater relations, *River flow, *Streamflow, *Infiltration, *Channel erosion, *Bank protection, *Soil cement, *Hydraulics, Flood control, Recharge, Computer simulation, Rillito River, Arizona.

A saturated-unsaturated flow model (UNSAT2) was used to study the effect of soil cementing and channel widening on infiltration and recharge in two idealized profiles along the Rillito River of southern Arizona. The channel sections associated with the profiles are 202-ft (61.6-m) and 326-ft (99.4-m) wide. A synthetic 10-yr runoff in the river provides head values for generating infiltration before and after bank protection in these two sections. Results from the two base simulations are combined to produce four additional cases. Soil cementing the banks of the river without widening the channel reduces infiltration and recharge by 15% for the 326-ft wide channel and by 25% for the 202-ft wide channel. Increasing channel width together with bank protection increases infiltration 25% for the two sections. Increasing channel width without bank protection, however, increases infiltration by 46%. Channel narrowing with bank protection markedly increases infiltration rates, about 50% for the two sections. (Author's abstract)
W90-04122

GEOMORPHIC EFFECTS OF TWO STORMS ON THE UPPER WAITAHAIA RIVER CATCHMENT, RAUKUMARA PENINSULA, NEW ZEALAND.
New Zealand Forest Service, Rotorua. Forest Research Inst.
For primary bibliographic entry see Field 2J.
W90-04131

PHYSICAL HYDRAULIC MODELLING OF WIDTH REDUCTION AND BED LEVEL CHANGE IN BRAIDED RIVERS.
Lincoln Coll., Canterbury (New Zealand). Dept. of Natural Resource Engineering.
For primary bibliographic entry see Field 2J.
W90-04132

SOME RECENT DEVELOPMENTS OF CONSTANT-INJECTION SALT DILUTION GAUGING IN RIVERS.
Department of Scientific and Industrial Research, Christchurch (New Zealand). Water Resources Survey.
For primary bibliographic entry see Field 7B.
W90-04133

NITRATE CONCENTRATIONS IN RIVER WATERS IN THE SOUTH-EAST OF IRELAND AND THEIR RELATIONSHIP WITH AGRICULTURAL PRACTICE.
Regional Water Lab., Kilkenny (Ireland).
For primary bibliographic entry see Field 5B.
W90-04141

PROGRAM TO CALCULATE CHANNEL SCOUR AND FILL.
Pacific Northwest Forest and Range Experiment Station, Juneau, AK. Forestry Sciences Lab.
For primary bibliographic entry see Field 2J.
W90-04169

ESTIMATING ANNUAL FLOOD PROBABILITIES USING FOURIER SERIES METHOD.
Academia Sinica, Beijing (China). Inst. of Geography.
K. Wu, and M.-K. Woo.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 743-750, August 1989. 5 fig, 2 tab, 12 ref.

Descriptors: *Fourier analysis, *Flood forecasting, *Flooding, Mathematical equations, Canada, Simulation analysis, Data processing.

The Fourier series method is proposed as a feasible non-parametric approach for the estimation of the density and distribution functions of annual floods. This method is easy to use and can estimate both the density function and the distribution function. Clearly, the goodness of fit to empirical data improves as higher Fourier terms are incorporated, and the choice of a higher term depends on whether the inclusion of this term will reduce the fitting error to within a specified tolerance level. The goodness of fit was tested by applying this non-parametric method to the annual flood data from eight Canadian rivers of different sizes and in different environments and to data simulated using known distributions. Unlike parametric methods that assume that the observed data follow certain distributions, the non-parametric approaches have no such restrictions. The results are clearly better than other parametric methods, just like other non-parametric techniques currently used to estimate annual flood probabilities. (Author's abstract)
W90-04170

FLOW PERSISTENCE AS A MODIFIER OF SEASONAL RUNOFF PATTERNS.
W. M. Synder, A. W. Thomas, and A. L. Dillard.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 809-820, August 1989. 8 fig, 4 tab, 8 ref.

Descriptors: *Flow persistence, *Base flow, *Model studies, *Rainfall-runoff relationships, *Runoff forecasting, Seasonal variation, Mapping, Data interpretation, Persistence, Case studies.

The effect of flow persistence on seasonal patterns of watershed runoff was modeled by using runoff of the immediate antecedent month as an index. Monthly runoff was expressed as a function of monthly rainfall, season of the year, and runoff of the antecedent month. The three independent variables were expressed functionally as sliding polynomials, thus producing a piece-wise, form-free, three-dimensional causative structure. A model form allowing complete interactivity of the three independent variables could not be optimized because of insufficient data with high values of both antecedent runoff and monthly rainfall. A model with reduced interactivity was successfully optimized. Data sets from five watersheds ranging from 0.14 to 398 sq mi were analyzed. Results were presented as a series of contour maps that showed contours of monthly runoff in the data space of season and monthly rain. In the series of maps, the patterns of the runoff contours changed with changing values of antecedent runoff. During the wet season of the year the contours changed significantly with antecedent runoff, but the changes in the dry season were minimal. The quantitative

change of runoff was more rapidly portrayed with cross-sections through the contoured surfaces. (Author's abstract)
W90-04178

HUMAN STABILITY IN A HIGH FLOOD HAZARD ZONE.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. R. Abt, R. J. Wittler, A. Taylor, and D. J. Love.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 881-890, August 1989. 6 fig, 3 tab, 6 ref.

Descriptors: *Flood damage, *Flood hazard, Simulation analysis, Stability, Flow velocity, Flood flow.

The delineation of high flood hazard zones within a flood plain is usually independent of the hydraulic parameters that constitute a life threatening situation. In order to define human instability in high hazard areas, a study was conducted to identify when an adult human could not stand or maneuver in a simulated flood flow. An analysis was performed on a rigid body monolith resulting in a toppling hazard envelope curve (velocity v. depth). A 120 lb monolith was then constructed and tested to relate the actual flow velocity and depth at toppling to theory. A series of human subjects (90-201 lbs) were placed in a recirculating flume and tested to determine the velocity and depth of flow that caused their instability. The test results determined that the product number, which is the product of the velocity and depth at toppling of the monolith, closely compared to the theoretical envelope curve. The monolith results represent the lower limit of human stability. Also, the product number appeared to be a predictor of human instability in flood flow. A relationship was developed to estimate the product number at which a human subject becomes unstable as a function of the height and weight of the subject. (Author's abstract)
W90-04186

PLUME OF THE YUKON RIVER IN RELATION TO THE OCEANOGRAPHY OF THE BERING SEA.
Alaska Univ., Fairbanks. Geophysical Inst.
K. G. Dean, C. P. McRoy, K. Ahlnas, and A. Springer.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 75-84, April/June 1989. 8 fig, 18 ref. NASA NAS 5-28769, NSF DPP-840 5286.

Descriptors: *Remote sensing, *Bering Sea, *Satellite technology, *Alaska, *Oceanography, *Water circulation, *Landsat, Temperature, Suspended sediments, Phytoplankton, Comparison studies, Data acquisition.

Physical and biological oceanography of the northern Bering Sea including the plume of the Yukon River were studied using satellite data in conjunction with shipboard measurements. The satellite data recorded by the NOAA Very High Resolution Radiometer (VHRR) and Advanced Very High Resolution Radiometer (AVHRR), and the Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) sensors were used to detect sea surface temperatures and suspended sediments. Shipboard measurements of temperature, salinity, and chlorophyll were acquired by the Inner Shelf Transfer and Recycling (ISHTAR) project and were compared to digitally enhanced and archived satellite images. Sea surface temperatures derived from satellite data were generally higher than field measurements. Satellite data confirmed the known distribution of water masses in the region. Areal patterns of temperature, salinity, and phytoplankton distribution, determined from field measurements, agreed reasonably well with patterns of water mass distribution obtained from satellite images. Archived satellite images (1974-1978) were used to investigate the variability of the distribution of sea surface temperature and of the turbid plume of the Yukon River. Alaskan Coastal Water (ACW) first warms near the coast in June and the process extends seaward as summer progresses. Turbid water associated with discharge of the Yukon River progresses in the same fashion, extending northward across the entrance to Norton Sound. Maximum extent of the plume occurs in October. Anadyr Water flows north through Anadyr Strait past St. Lawrence Island; its extent is variable depending on mesoscale pressure and local wind fields. (Author's abstract)
W90-04194

NEW LOOK AT FLOOD RISK DETERMINATION.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
C. Booy, and L. M. Lye.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 933-943, October 1989. 5 fig, 1 tab, 20 ref, 2 append.

Descriptors: *Model studies, *Flood forecasting, *Flood hazard, *Flood frequency, Hurst coefficient, Canada, Correlation analysis, Flood peak.

The probability distributions of annual peak flows used in flood risk analysis quantify the risk that a design flood will be exceeded. However, the parameters of these distributions are themselves to a degree uncertain and this uncertainty increases the risk that the flood protection provided will in fact prove to be inadequate. The increase in flood risk due to parameter uncertainty is small when a fairly long record of data is available and the annual flood peaks are serially independent, which is the standard assumption in flood frequency analysis. However, standard tests for serial independence are insensitive to the type of grouping of high and low values in a time series, which is measured by the Hurst coefficient. This grouping increases the parameter uncertainty considerably. A study of 49 annual peak flow series for Canadian rivers shows that many have a high Hurst coefficient. The corresponding increase in flood risk due to parameter uncertainty is shown to be substantial even for rivers with a long record, and therefore should not be neglected. A method of rationally combining parameter uncertainty due to serial correlation, and the stochastic variability of peak flows in a single risk assessment was developed. The mixed-noise model provides a simple and fast tool for the generation of a data series with a correlation structure that corresponds to a given lagone correlation coefficient and a given Hurst coefficient. (Author's abstract)
W90-04197

STAGE DISTRIBUTION APPROACH TO ESTIMATING ICE RELATED FLOODING PROBABILITIES.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W90-04199

COMPARISON OF REGRESSION AND TIME-SERIES METHODS FOR SYNTHESIZING MISSING STREAMFLOW RECORDS.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 7C.
W90-04200

COMPARISON OF STREAMFLOW GENERATION MODELS FOR RESERVOIR CAPACITY-YIELD ANALYSIS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. A. Savic, D. H. Burn, and Z. Zrinji.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 977-983, October 1989. 6 tab, 13 ref.

Descriptors: *Reservoir yield, *Model studies, *Reservoir capacity, *Streamflow forecasting, Comparison studies, Statistical analysis, Critical flow, Historical records.

An analysis of four streamflow generation schemes for the use in the estimation of the required conservation storage for a single reservoir is presented. The comparison of the generating schemes should aid in the selection of an appropriate model type for the reservoir sizing problem. The streamflow generation models are compared using two criteria. The first comparison is between the statistics of the generated streamflow sequences and the corresponding statistics from the historical record. The second evaluation compares the median reservoir size determined by each model with the required storage based on the historical flow sequence. The results demonstrate that the type 3 disaggregation model (MVS) is a superior generating scheme, relative to the alternatives considered, for the reservoir sizing problem. It is apparent that simply comparing the moments of the generated and historical sequences is not sufficient to obtain an unequivocal ranking of the generating schemes. Three candidate models provided satisfactory agreement with the historical statistics, but the storage values obtained with the three models were markedly different. The determination of required reservoir capacity is controlled by the critical flow period in the inflow sequence. It is therefore possible for a model to adequately reproduce the historical moments, but do a poor job of reproducing critical flow periods. It is therefore essential to consider other aspects of the generated flow sequences. (Author's abstract)
W90-04201

EVALUATION OF INFLOW TO MIRROR LAKE, NEW HAMPSHIRE.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2H.
W90-04203

COARSE WOODY DEBRIS AND CHANNEL MORPHOLOGY: A FLUME STUDY.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
For primary bibliographic entry see Field 8I.
W90-04207

APPLICATION OF THE U.S.G.S. DIFFUSION HYDRODYNAMIC MODEL FOR URBAN FLOODPLAIN ANALYSIS.
Williamson and Schmid, Irvine, CA.
T. V. Hromadka, T. R. Walker, C. C. Yen, and J. J. DeVries.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1063-1071, October 1989. 6 fig, 11 ref.

Descriptors: *Flood forecasting, *Design floods, *Flood hazard, *Flood maps, *Model studies, Diffusion Hydrodynamic Model, Flood plain management, Flood forecasting, Indirect flood measurement.

The two-dimensional Diffusion Hydrodynamic Model, DHM, is applied to the evaluation of floodplain depths resulting from an overflow of a leveed river. The environmental concerns of flood protection and high flow velocities can be better studied with the help of the two-dimensional DHM flow model than by use of the one-dimensional modeling techniques. In addition, a flowpath reduction factor and the effective grid area were added to the DHM for a more realistic representation of the field condition. In the test case, some of the predicted flood depth differences between the DHM and the one-dimensional approach (i.e., HEC-2) are found to be significant. The DHM analysis resulted in a wider floodplain, and consequently, lower watersurface elevations at some locations that the results from the Flood Insurance Rate Map. Although the DHM generates considerable information, it is easy to use and does not require expertise beyond that required for use of the one-dimensional approaches. (Author's abstract)
W90-04212

HYDROLOGIC AND HYDRAULIC ANALYSIS FOR LAS VEGAS WASH AND TRIBUTARIES, NEVADA.
Army Engineer District, Los Angeles, CA.
J. B. Evelyn.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 11-26, 2 fig, 2 tab, 9 ref.

Descriptors: *Flood forecasting, *Nonstructural alternatives, *Hydrologic aspects, *Hydraulics, *Water resources management, Las Vegas Wash, Feasibility studies, Decision making, Nevada, Reconnaissance studies.

This paper was prepared as part of the August 1988 Seminar on Flood Damage Reduction for Reconnaissance Phase Studies held at the Hydrologic Engineering Center. Although the emphasis is on reconnaissance phase studies, the hydrologic and hydraulic analysis performed in support of both the reconnaissance and feasibility phase studies for Las Vegas Wash and Tributaries, Nevada, are presented and compared. During the reconnaissance phase, maximum utilization was made of prior studies in order to quantify existing and future flood damage potential, and evaluate alternative flood hazard reduction measures in the short time frames and minimal funding available at this phase. In the feasibility phase, additional time and funding resources permitted hydrologic and hydraulic analysis consistent with U.S. Army Corps of Engineers guidance requirements, but not without accommodation of the needs and requirements of the local cost sharing sponsor. The feasibility hydrologic analysis resulted in large changes in the discharge frequency relationships for the Las Vegas region. Based on the Corps of Engineers Los Angeles District's experience with the Las Vegas study among others, several ideas with regard to the Corps' current flood control study program are worth presenting: (1) When adopting hydrologic and hydraulic work by Architect-Engineer firms or other agencies, one must recognize that significant changes in the technical results can occur following more detailed Corps analyses; (2) Hydrologic analysis is the first technical activity on any flood control study. Given the ripple effect on the entire study process, reconnaissance through design phases, the hydrologic analysis should be addressed in as much detail as practical at the earliest possible opportunity in the overall study process; and (3) With the advent of cost sharing, Corps technical elements must be prepared to use or adopt methodology that may be unfamiliar in order to meet the needs of local sponsors. (See also W90-04234) (Lantz-PTT)
W90-04236

RECONNAISSANCE STUDY FOR OVERLAND PARK.
Overland Park, KS.
For primary bibliographic entry see Field 6F.
W90-04244

MINNESOTA WATER: A GEOGRAPHICAL PERSPECTIVE.
Minnesota Univ., Minneapolis. Dept. of Geography.
C. Gersmehl, J. Drake, and D. Brown.
Public Report Series No. 4, May 1986. 32p, 36 ref.

Descriptors: *Water resources data, *Hydrologic data collections, *Minnesota, *Water resources, *Geography, Available water, Water use, Maps, Water demand, Hydrologic budget, History.

A common perception is that Minnesota is very rich in water resources. Those who depend on water resources know too well that the signs of abundance can be misleading. Indeed, Minnesota does have problems related to the quantity of water--times of excess or of insufficiency. This summary of Minnesota's water resources has three parts. The first two deal with geographic and historical variations in water availability and in patterns of water use. The final section presents a variety of water problems and issues that affect resource users at various locations and at various times in the state. (Lantz-PTT)
W90-04266

STORMWATER MANAGEMENT: PROCEDURES AND METHODS, A MANUAL OF BEST MANAGEMENT PRACTICES.
URS Co., Seattle, WA.
For primary bibliographic entry see Field 4A.
W90-04267

GEOLOGY, HYDROLOGY AND HISTORY OF THE WASHINGTON, D.C. AREA.
American Geological Inst., Alexandria, VA.
For primary bibliographic entry see Field 2A.
W90-04271

COMPUTER AIDED DESIGN SOFTWARE IN FLUVIAL HYDRAULICS: PROGRAM CADRIV.
Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04295

SIMILARITIES AND DIFFERENCES IN THE NATURE OF GROUND AND SURFACE WATER DATA AND THE IMPLICATIONS FOR DESIGNING PERSONAL COMPUTERS DATA SYSTEMS.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W90-04301

IMPROVED HYDROLOGIC FORECASTING: WHY AND HOW.
For primary bibliographic entry see Field 2A.
W90-04308

TECHNIQUES FOR THE GENERATION OF LONG STREAMFLOW SEQUENCES.
Hydrocomp, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 7C.
W90-04310

PROBLEMS IN OPERATIONAL HYDROLOGIC FORECASTING.
Sierra Hydrotech, Placerville, CA.
J. F. Hannaford, and R. L. Hall.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 47-64, 7 fig.

Descriptors: *Hydrology, *Forecasting, *Hydrologic models, *Data interpretation, *Streamflow forecasting, *Model studies, *Water management, Water supply, Error analysis, Errors, Decision making.

There are many techniques, procedures, and hydrologic models which have been developed pertinent to water supply forecasting representing methodologies currently in use. Forecasts of water supply which are intended for public distribution through the media may be very different in concept and presentation from those intended for water management decision making and operational planning. Forecast methodology for operational forecasting is extremely dependent on the intended use of the forecasts. In general, the shorter the time period of runoff being forecast (i.e. days or weeks as opposed to season or water year), the more sophisticated the technique required. No single forecasting technique has a clear cut advantage over all others. Hydrologic models do, for the most part, represent a more sophisticated and possibly more realistic approach to simulation of streamflow than to index correlation techniques. Forecast error, particularly early in the forecast season is highly dependent upon variability of weather conditions subsequent to the date of forecast. This weather related error decreases as the season progresses. An accurate and realistic understanding of 'forecast error', its magnitude, composition, and characteristics, is extremely important in application of hydrologic forecasts to decision making in water management. This applies to all types of hydrologic forecasting, whether water supply or other types of hydrologic forecasts. The water manager must understand the necessity for developing operational plans contingent upon the probability of certain climatologic and hydrologic conditions materializing. He must recognize that extreme conditions could be more critical than those observed in limited past record and although the probability of such extremes being encountered might be low, certain operational restraints may require consideration of such extremes. Misunderstanding or misinterpretation of the nature, magnitude and time-relationship of forecast error may be one of the most critical problems faced in water management at the present time. (See also W90-04308)(Lantz-PTT)
W90-04311

GEOMORPHIC EVIDENCE OF FREQUENT AND EXTREME FLOODS.
Wisconsin Univ.-Madison. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-04322

AUGMENTATION OF HYDROLOGIC RECORDS USING TREE RINGS.
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
For primary bibliographic entry see Field 7B.
W90-04323

CALIFORNIA DROUGHT--ITS EFFECT ON RUNOFF FORECASTING FOR POWER GENERATION.
Pacific Gas and Electric Co., San Francisco, CA.
G. J. Freeman.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 266-273, 5 ref.

Descriptors: *Drought, *Runoff forecasting, *Streamflow forecasting, *Management planning, *California, Powerplants, Industrial water, Flood forecasting, Prediction.

The 1976-1977 two year California Drought is now a recorded fact. For those involved with runoff forecasting and water planning, the drought in spite of its serious impact on the state's resources, was a significant event for future water studies. The drought's effect on runoff forecasting in general will be that the data now exists for two very dry years. Planning cannot ignore the possibility that there will be other years with similar extremes. Reservoir carry-over the possibility of another drought of similar magnitude. Runoff forecasting during the drought provided the input for both fuel procurement and operational planning. The methods used shifted from the rigid equation method to the more subjective 'best judgement/common sense approach.' Inspection of rank ordered data was very helpful in accomplishing this. It is important to have the flexibility to use alternative approaches during an extreme situation such as occurred during the drought. Reasonable numbers were forecasted as a result of using a subjective approach in this case. The drought data however, now exists to develop equations with better defined low ends of flow than was previously possible. The reliability of equations to predict during a drought situation has been greatly enhanced as a result of the dry year data now available. (See also W90-04308)(Lantz-PTT)
W90-04324

BPA HYDROLOGIC FORECASTING CONSIDERATIONS AND ACTIONS DURING THE 1976-77 DROUGHT.
Bonneville Power Administration, Vancouver, WA. Hydrometeorology Section.
For primary bibliographic entry see Field 7C.
W90-04325

CHANGING NEEDS IN URBAN FLOOD FORECASTING.
Urban Drainage and Flood Control District, Denver, CO.
L. S. Tucker.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 295-302.

Descriptors: *Urban areas, *Urban hydrology, *Flood forecasting, Flood peak, Flood hydrographs, Urban runoff, Forecasting, Economic aspects, Storm water, Flood warning systems.

Urban flood forecasting consists of two basic needs. The first is the forecasting of peak flows and hydrographs for the purpose of planning and design of urban drainage and flood control systems. The second is the forecasting of impending flood events for the purpose of warning flood plain occupants of the potential hazard. Both needs represent current activities, but the changing need is for improved or more reliable flood forecasting capabilities. Some of the reasons for this changing need include the following: the high cost of drainage and flood control facilities make the 'accurate' estimation of flows more important. The potential liability of public officials for their actions places a greater need on reliability of designs. The onus of not warning of a flood or issuing warnings when no floods occur can be a serious problem to a public works official. When 100-year flood plains are defined for regulation purposes, the delineation must be defensible in court as being based on the best that the state-of-the-art can offer. The requirement to provide detention of stormwater flows requires that an entire hydrograph be predicted which is more complex than just estimating a peak flow. The concern about receiving water quality and the pollution effect of urban storm runoff complicates the picture significantly. These developments are all contributing to steadily changing needs in urban flood forecasting. The changing needs in general require more accurate urban flood forecasting. To obtain more accurate forecasting, research based on local rainfall/runoff data is required. Metropolitan areas with foresight are conducting data collection and analysis programs to allow them to better cope with the changing needs in urban flood forecasting. (See also W90-04308)(Lantz-PTT)
W90-04327

LET'S LOOK AT SOME LEGAL IMPLICATIONS OF STREAMFLOW FORECASTING.
Stetson Engineers, Inc., San Francisco, CA.
For primary bibliographic entry see Field 6E.
W90-04329

FLOOD PLAIN MANAGEMENT NEEDS.
Office of the Chief of Engineers (Army), Washington, DC. Flood Plain Management Services Branch.
G. R. Phippen.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 322-332, 2 fig.

Descriptors: *Flood plain management, *Communication, Classification, Decision making, Hydrology, Hydraulics, Flood plains, Public participation.

Three subjects--hydrology and hydraulics, occupance, and environmental values--form the main foundations for floodplain management. Otherwise, floodplains are governed by the rules and conditions that apply to other areas of the community and region. Since these three basic foundations are interactive, the needs for floodplain management go beyond the sum of the parts. A need exists for care in communicating ideas through the development of a common set of terminology. Specifically, for suggested terminology concerning flooding conditions exceeded: 'frequently, fairly frequently, fairly rarely, rarely, and very rarely.' Distinctions concerning planner versus scientist versus user are addressed, although it is the layman who is the ultimate decision maker. A basis for working with the concepts of floodplain management has been provided through the Unified National Program of Floodplain Management. Improvements in techniques in all areas--physical, economic, social--are both needed and possible. The most obvious need appear to be in the area of understanding by the general public. (See also W90-04398) (Lantz-PTT)
W90-04330

MAINTENANCE OF INSTREAM FLOWS.
Michigan State Univ., East Lansing. Inst. of Water Research.
D. King.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 114-120.

Descriptors: *Urban hydrology, *Water pollution control, *Instream flow, *Water quality control, *Urban areas, Water supply, Reservoirs, Water quality, Stream discharge, Surface water, Sedimentation, Wastewater dilution.

The great variety of users of a river all have well defined individual wants from the river, and many of these wants are incompatible. these incompatibilities occur on all rivers to some extent but are magnified greatly during urbanization of a river basin. The three topics of this discussion--water quality control, maintenance of instream flow, and availability of surface water for consumptive use--form a triad which brings to focus many of the incompatible aspirations of the various public users of river basins subjected to accelerated urbanization. Despite significant effort at wastewater treatment, reliance is still placed on dilution for control of water quality. The finite limits to the dilution capacity of natural waters are evident in the continued degradation of many rivers and lakes even where real efforts have been made to control wastewater input. The technologies for maintaining minimum stream discharge are essentially limited to two considerations: (1) prohibition on removing water from the stream; and (2) construction of impoundments to capture water in times of plenty for release during periods of scarcity. The inability to control point and nonpoint sources and the heavy sediment loads characteristic of urbanizing watersheds pose real problems for impoundments. Dredging of sediments and control of excess aquatic plants are energy demanding operations, and management problems are associated with this course of action. Increased evaporative loss of water is yet another cost associated with such impoundments. Availability of water from a given stream for consumptive use is dependent on both quantity and quality of the stream relative to that demand by the use in question. Quantity of water available can be increased by construction of impoundments, but quality is largely a function of the dilution capacity of the river relative to the waste load from the basin. Given adequate quantities of water, a variety of energy demanding processes are often required to upgrade water quality to a level suitable for a given use, with the amount of energy required increasing with decreased river water quality. (See also W90-04338)(Lantz-PTT)
W90-04351

EFFECTS OF URBANIZATION ON STREAMS.
Turner, Collie and Braden, Inc., Houston, TX.
For primary bibliographic entry see Field 4C.
W90-04365

LOCAL CONTROL OF FLOOD DAMAGE.
North Carolina Univ. at Chapel Hill. Dept. of City and Regional Planning.
For primary bibliographic entry see Field 4A.
W90-04367

CHEMICAL PROPERTIES OF SOILS AND STREAMS IN NATURAL AND DISTURBED FOREST ECOSYSTEMS IN THE OUACHITA MOUNTAINS.
Arkansas Univ. at Monticello. Dept. of Forest Resources.
R. S. Beasley, E. L. Miller, and E. R. Lawson.
Arkansas Water Resources Research Center, University of ARkansas, Fayetteville, AR. Publication No. 132, June 1987. Technical Completion Report Research Project G-1212-02. 93p. 1 fig, 5 tab, 22 ref, append.

Descriptors: *Forest hydrology, *Land use, *Soil chemistry, *Streams, *Water chemistry, *Forest ecosystems, Forest watersheds, Clear-cutting, Cycling nutrients, Arkansas.

One year of pre-harvest and five years of post-harvest water chemistry data were collected and analyzed for nitrate nitrogen, total kjeldahl nitrogen (TKN), total phosphorus, organic phosphorus (OP), potassium, and calcium on nine small watersheds in the Ouachita Mountains of central Arkansas. Gross exports of all nutrients except TKN were significantly increased by clearcutting followed by mechanical site preparation and broadcast burning of slash. Discharge-weighted nutrient concentrations were increased only for OP, K and Ca. The treatment effect was brief, lasting only one year. The first harvest of a selection system regime had no measurable effect on gross losses or concentrations of nutrients. Precipitation chemistry measurements from the region indicated that annual imports of all nutrients considered in this study generally exceed the gross losses measured. However, because of the possible threat to soil fertility by the leaching effects of acid deposition, foresters should be especially vigilant in their efforts to protect site productivity where soils are low in base cations.(Author's abstract)
W90-04494

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1984.
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04530

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1984.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04531

WATER RESOURCES DATA FOR ARIZONA, 1983.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-04532

WATER RESOURCES DATA--ARKANSAS, WATER YEAR 1984.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04533

WATER RESOURCE DATA--ARKANSAS, WATER YEAR 1985.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04534

WATER RESOURCES DATA FOR CALIFORNIA, 1983. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04535

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1983 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04536

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO

OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04537

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04538

WATER RESOURCES DATA FOR CALIFORNIA, 1984 VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04539

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04540

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04541

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04542

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04543

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04544

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04545

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1983.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04546

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1984.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04547

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1A: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04548

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1B: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL.
For primary bibliographic entry see Field 7C.
W90-04549

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04550

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04551

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 3B: SOUTHWEST FLORIDA - GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04552

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1983. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04553

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 1A: NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04554

2F. Groundwater

PROCEEDINGS, MISSISSIPPI WATER RESOURCES CONFERENCE.
Mississippi Water Resources Research Inst., Mississippi State.
For primary bibliographic entry see Field 5F.
W90-03708

GROUNDWATER SENSITIVITY MODELING USING GIS TECHNOLOGY.
Mississippi Research and Development Center, Jackson.
For primary bibliographic entry see Field 5G.
W90-03711

APPARENT CHANGES IN THE POTENTIOMETRIC SURFACES OF CRETACEOUS AND PALEOZOIC AQUIFERS OF NORTHEASTERN MISSISSIPPI, 1955-1988.
Mississippi Bureau of Pollution Control, Jackson.
J. H. Hoffmann, and P. A. Phillips.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 77-84. 6 fig, 15 ref.

Descriptors: *Potentiometric surface, *Aquifer systems, *Subsurface mapping, *Aquifers, *Mississippi, *Groundwater recession, *Groundwater movement, *Geohydrology, *Water table decline, Water demand, Water use, Hydrologic models, Water level, Sand aquifers, Geologic history, Groundwater recharge, Water supply.

A series of potentiometric maps are presented, based on selected water level data from the Coffee Sand, Eutaw-McShan, Gordo, and Paleozic aquifers in northeastern Mississippi. These aquifers constitute important sources of fresh water in this region and have been subjected to progressive stress for many years due to an increasing demand for public and industrial water supplies. The response of these aquifer systems to the stresses caused by these withdrawals of water has been a general long-term decline in regional water levels and more dramatic decline near centers of greater pumpage. These maps represent the first element in the development of a layered groundwater flow model of the aquifer systems underlying this part of Mississippi. Results of the model indicate that throughout the period since 1955, water levels in and near the recharge areas of these aquifer systems have shown little or no significant declines. Water levels in the confined areas of the Coffee Sand have declined at an average rate of 1 to 2 feet/yr less during this time. In the confined portions of the Eutaw-McShan aquifer system, water levels have generally declined at an average rate of 1 to 2 ft/yr except in the vicinity of the pumping centers at Tupelo and West Point, where declines of about 3-5 ft/yr have occurred since 1955. Similar water level declines are apparent in the Gordo aquifer system except at West Point where the declines appear to be about 2-3 ft/yr. At Corinth, the Paleozoic aquifer has apparently experienced an average decline of as much at 3-4 ft/yr at some locations since the early 1960s. (See also W90-03708) (Friedmann-PTT)
W90-03723

GROUNDWATER EXTRACTION TRENDS IN FOREST AND LAMAR COUNTIES, MISSISSIPPI.
University of Southern Mississippi, Hattiesburg. Dept. of Geology.
D. M. Patrick, and S. Zhao.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 85-90. 6 fig, 3 tab, 9 ref.

Descriptors: *Mississippi, *Groundwater recession, *Groundwater depletion, *Water use, *Aquifers, *Drawdown, Piezometers, Aquifers, Model studies, Hydrologic studies, Geohydrology, Shallow aquifers, Water table decline, Computer programs, Piezometric surface.

Computer graphics are used to document and describe the local and regional historical drawdown of piezometric surfaces in Forrest and Lamar Counties, Mississippi. The geologic framework of the aquifers in the region were studied. The studies are part of a more comprehensive investigation dealing with the development of predictive groundwater models for the aquifers of Forrest, Lamar, and Jones Counties. The drawdown data show that there has been significant reduction of piezometric surface elevations over the last 27 years, both regionally in the two-county areas, and at the major population centers at Hattiesburg and Purvis. The drawdown behavior of the shallow aquifer has been more irregular than that of the deep aquifer, in that the piezometric surfaces of the former have exhibited periodic and temporary increases in elevation, whereas the latter exhibited a more constant decline. These differences in aquifer

behavior may be partially explained by local recharge and topographic effects in the shallow aquifer, which is not fully confined. The examination and comparison of piezometric surface contour maps show a distinct rise and fall of the surface as old well fields were either abandoned or pumping was decreased in them and when new wells were established in other areas. Assuming that this rate continues at approximately three ft/yr, 20 years of further continued decline at this rate will reduce the piezometric surface elevation very nearly to that of the top of this aquifer. (See also W90-03708) (Friedmann-PTT)
W90-03724

PRELIMINARY STEADY-STATE SIMULATION OF GROUNDWATER FLOW IN HINDS, MADISON, AND RANKIN COUNTIES, CENTRAL MISSISSIPPI.
Mississippi Bureau of Land and Water Resources, Jackson.
J. R. Spencer.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 91-103. 13 fig, 1 tab, 10 ref.

Descriptors: *Mississippi, *Groundwater movement, *Geohydrology, *Aquifers, *Hydrologic models, *Simulation, Paleohydrology, Confined aquifers, Vertical flow, Water table fluctuations, Water level, Regional development, Water table decline, Steady flow, Pumpage, Drawdown, Regional analysis.

The aquifer systems underlying Hinds, Madison, and Rankin Counties in central Mississippi were studied by the Geological Survery in cooperation with the State of Mississippi. Intensive development of these aquifers, primarily within the Jackson Metropolitan Area, has resulted in significant water-level declines. The hydrologic system was simulated using the U.S.G.S.'s modular three-dimensional, finite-difference groundwater flow model. The model has six layers with each layer representing the following aquifers in descending order: (1) Miocine-Oligocene aquifer system, (2) Cockfield aquifer, (3) Sparta aquifer, (4) Meridian-upper Wilcox aquifer, (5) middle Wilcox aquifer, and (6) lower Wilcox aquifer. The model has 50 rows and 70 columns and each cell is 5 miles on a side. Model simulations indicate that groundwater flow in the regional study area moves downdip from the outcrop area and upward through the confining units as it traverses toward the Mississippi embayment axis. Under stressed conditions using 1980 pumpage rates, model-simulated vertical flow between aquifers ranges from 0.26 million cu ft/d (1.94 Mgal/d) from the Miocene-Oligocene aquifer system downward to the Cockfield aquifer to 14.14 million cu ft/d (105.77 Mgal/d) from the Cockfield aquifer downward to the Sparta aquifer. Water level measurements made in 1980 indicate that the Sparta aquifer is the most severely stressed. The other aquifers have significant drawdown only in localized areas of heavy pumpage. The simulations completed by this regional analysis have shown a need to develop a fine-grid groundwater flow model in this area. The analysis will provide water managers with a tool incorporting more usable information to better understand the groundwater flow system, analyze the effects of groundwater use, and to evaluate pumpage scenarios for the future in the study area. (See also W90-03708) (Friedmann-PTT)
W90-03725

POTENTIOMETRIC SURFACES OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS, SPRING 1972 AND 1980.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-03753

METHODOLOGY, RESULTS, AND SIGNIFICANCE OF AN UNSATURATED-ZONE TRACER TEST AT AN ARTIFICIAL-RECHARGE FACILITY, TUCSON, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
D. D. Graham.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4097, 1989. 28p, 6 fig, 3 tab, 45 ref.

Descriptors: *Artificial recharge, *Unsaturated zone, *Path of pollutants, *Unsaturated flow, *Arizona, Tucson, Recharge, Infiltration, Storm runoff, Urban hydrology.

A tracer test conducted in 1987 at an artificial-recharge facility in Tucson, Arizona, indicates that solute movement through the poorly sorted stratified alluvial sediments in the unsaturated zone beneath a recharge basin takes place along preferential-flow paths. Movement of a tracer-laced pulse of reclaimed wastewater was monitored using pressure-vacuum lysimeters installed at depths that range from 11 to 45 ft below the bottom of the recharge basin. Tracer-breakthrough curves do not indicate a consistent relation between maximum tracer concentration and depth or between time of tracer breakthrough and depth. Apparent dispersion, as indicated by the slope of the rising leg of the tracer-breakthrough curve, shows no apparent relation with depth. In some cases, the tracer arrived earlier at deep sampling locations than at shallow ones. Velocity of solute flow ranged from 1.9 to 9.0 ft/day. Less interaction between recharge water and solid-phase materials in the unsaturated zone occurs under preferential-flow conditions than if flow occurred as a uniform wetting front. Flow of water through the unsaturated zone is concentrated into fingers or channels under preferential-flow conditions, and the renovating capability of soil is reduced because of the reduced surface area and reduced contact time in the biologically active part of the unsaturated profile. Chemical substances that normally would be decomposed by microbial activity or sorbed by sediment particles can move through the unsaturated zone and cause groundwater contamination under preferential-flow conditions. (USGS)
W90-03754

PUBLIC POLICY ON GROUND WATER QUALITY PROTECTION.
For primary bibliographic entry see Field 5G.
W90-03771

MAGNITUDE OF THE GROUND-WATER CONTAMINATION PROBLEM.
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 5B.
W90-03772

NON-DEGRADATION AS A GROUND-WATER QUALITY POLICY.
National Audubon Society, New York.
For primary bibliographic entry see Field 5G.
W90-03773

LIMITED DEGRADATION AS A GROUND-WATER QUALITY POLICY.
Army Armor Center, Fort Knox, KY.
For primary bibliographic entry see Field 5G.
W90-03774

IMPACT OF FEDERAL LEGISLATION OTHER THAN THE SAFE DRINKING WATER ACT ON GROUND-WATER PROTECTION.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5G.
W90-03783

STATE APPROACH TO GROUND-WATER PROTECTION: THE PENNSYLVANIA EXPERIENCE.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Ground Water Section.
For primary bibliographic entry see Field 5G.
W90-03784

ROLE OF INTERSTATE COMMISSIONS IN GROUND-WATER PROTECTION: THE SUSQUEHANNA RIVER BASIN COMMISSION PERSPECTIVE.
Susquehanna River Basin Commission, Mechanicsburg, PA.
For primary bibliographic entry see Field 6E.
W90-03786

CONVIVIAL TECHNOLOGY AS A LOCAL APPROACH TO GROUND-WATER PROTECTION: THE CHRISTINA RIVER BASIN EXPERIENCE.
Pennsylvania Univ., Philadelphia. Center for Ecological Research.
For primary bibliographic entry see Field 5G.
W90-03787

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER COMMISSION VIEW.
Camp, Dresser and McKee, Inc., Belmont, CA. Water Resources Div.
For primary bibliographic entry see Field 6E.
W90-03788

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER WELL ASSOCIATION VIEW.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 6E.
W90-03789

HYDROLOGIC COMPONENT.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-03794

PALEOHYDROLOGY OF THE ANADARKO BASIN, CENTRAL UNITED STATES.
Geological Survey, Lawrence, KS. Water Resources Div.
D. G. Jorgensen.
Oklahoma Geological Survey Circular 90, 1989. p 176-193, 14 fig.

Descriptors: *Paleohydrology, *Diagenesis, Anadarko Basin, United States, Groundwater movement, History, Geohydrology, Geology, Sedimentation.

Geohydrologic systems in the Anadarko basin in the central United States are controlled by topography, climate, geologic structures, and aquifer hydraulic properties, all of which are the result of past geologic and hydrologic processes, including tectonics and diagenesis. From Late Cambrian through Middle Ordovician time, a generally transgressive but cyclic sea covered the area. The first deposits were permeable sand, followed by calcareous mud. During periods of sea transgression, burial diagenesis decreased porosity and permeability. During Pennsylvanian time, rapid sedimentation accompanied rapid subsidence in the Anadarko basin. A geopressure zone probably resulted when sediments with little permeability trapped depositional water in Lower Pennsylvanian sands. Burial diagenesis included compaction and thermal alteration of deeply buried organic material, which released carbon dioxide, water, and hydrocarbons. By Middle Pennsylvanian time, the sea had submerged most of the central United States, including the Ozarks, as tectonic activity reached its maximum. During Late Pennsylvanian and Early Permian time, the Ouachita uplift had been formed and was higher than the Ozarks. Uplift was accompanied by a regional upward tilt toward the Ouachita-Ozarks area; the sea receded westward, depositing large quantities of calcareous mud and clay, and precipitating evaporitic material in the restricted-circulation environment. By the end of Permian time, > 20,000 ft of Pennsylvanian and Permian sediments had been deposited in the Anadarko basin. These thick sediments caused rapid and extreme burial diagensis, including alter-

ation of organic material During Permian time in the Ozarks area, development of the Ozark Plateau aquifer system commenced in the permeable Cambrian-Mississippian rocks near the St. Francois Mountains as the Pennsylvanian confining material was removed. Since Permian time, uplift diagenesis has been more active than burial diagenesis in the Anadarko basin. Synopsis of paleohydrologic interpretation indicates that Cambrian-Mississippian rocks in the Anadarko basin should be relatively impermeable, except for local secondary permeability, because rocks in the basin have undergone little uplift diagenesis. (Lantz-PTT)
W90-03799

DOCUMENTATION OF COMPUTER PROGRAMS TO COMPUTE AND DISPLAY PATHLINES USING RESULTS FROM THE U.S. GEOLOGICAL SURVEY MODULAR THREE-DIMENSIONAL FINITE-DIFFERENCE GROUND-WATER FLOW MODEL.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7C.
W90-03815

GEOCHEMISTRY OF THERMAL WATER FROM SELECTED WELLS, BOISE, IDAHO.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2K.
W90-03820

METHOD FOR ESTIMATING THE WATER-TABLE ALTITUDE IN A COASTAL-PLAIN AQUIFER USING A GEOGRAPHIC INFORMATION SYSTEM.
Geological Survey, Denver, CO.
W. A. Battaglin.
IN: Geoscientific Information Systems Applied to Exploration and Research, Proceedings of a Conference held in Lakewood, Colorado, September 23-26, 1989. 1989. p 76-84, 4 fig, 7 ref.

Descriptors: *Water table, *Geographic information systems, *Mapping, *Coastal aquifers, *Information systems, Hydraulic conductivity, Groundwater recharge, Aquifer characteristics, Groundwater level.

An analytical method was developed that uses a geographic information system to solve the Dupuit-Forchheimer equation for estimating the unstressed water table altitude at nodes in a grid. The method was used to estimate the water table altitude in the unconsolidated sands and gravels of a river basin in the Coastal Plain of New Jersey. Estimated water table altitude values were generated from measured values of stream surface altitude and from values of stream surface altitude and gradient interpreted from the US Geological Survey 7.5 minute topographic maps. Estimates of horizontal hydraulic conductivity, groundwater recharge, and surficial aquifer thickness obtained from published reports were incorporated in the solution. The water table altitude was estimated at 8,904 nodes in the 77 sq mi study area. The accuracy of the method was tested by statistically comparing estimated altitude values with altitude values derived from a previously produced, manually interpreted water table surface map. Linear correlations between the estimated and interpreted altitude values produced sample correlation coefficients of 0.97 or more. Interpreted values of water table altitude range from 70 to 140 ft above sea level within the study area; the median of the absolute value of the residuals between the interpreted and estimated values was approximately 2.5 ft, and the first and third quartiles were approximately 1.2 and 4.6 ft, respectively. This method is useful for estimating water table altitude with a high degree of accuracy, and might be applicable to other unconsolidated hydrologic systems. (Author's abstract)
W90-03822

GROUND-WATER LEVELS IN THE ALLUVIAL AQUIFER AT LOUISVILLE, KENTUCKY, 1987-88.
Geological Survey, Reston, VA. Water Resources Div.
R. J. Faust, and B. E. Lyons.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4119, September 1989. 15p, 8 fig, 2 tab, 6 ref.

Descriptors: *Kentucky, *Alluvial aquifers, *Surface-groundwater relations, *Water table, *Water table gradient, *Groundwater movement, Pumping, Alluvium.

Water-level data have been collected in the alluvial aquifer at Louisville, Kentucky by the U.S. Geological Survey since 1943. Summaries and analysis of these data are published periodically to update the record and to help public officials who must manage this groundwater supply. Maps and hydrographs are presented in this report to update the record for 1987-88 and to interpret recent trends in water levels. The data show that groundwater levels were stable for the period 1980-86 after rising rapidly in the 1970's. There has been a slight decline in the water levels during 1987-88 because of below normal precipitation for the period 1985-88. The decline has been about 1 to 3 ft in wells along the Ohio River and about 3 to 6 ft in wells away from the influence of the river. Groundwater withdrawals have also caused slight declines in the water table in three areas in Louisville. Declines in downtown Louisville due to pumpage seem to be stabilizing at or slightly below the normal pool stage of the Ohio River which indicates that water is probably being induced from the river into the aquifer. (USGS)
W90-03873

STRATIGRAPHY OF THE UNSATURATED ZONE AT THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.
Geological Survey, Idaho Falls, ID. Water Resources Div.
S. R. Anderson, and B. D. Lewis.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4065, May 1989. Contract no. DE-AI07-81ID12306. Project no. ID-165. 54p, 24 fig, 2 tab, 16 ref.

Descriptors: *Geohydrology, *Radioactive waste disposal, *Stratigraphy, *Basalts, *Sediments, *Idaho, Idaho National Engineering Laboratory, Aeration zone.

A complex sequence of layered basalt flows, cinders, and sediment underlies the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory in southeastern Idaho. Wells drilled to 700 ft penetrate a sequence of 10 basalt-flow groups and 7 major sedimentary interbeds that range in age from about 100,000 to 600,000 years old. The 10 flow groups consist of 22 separate lava flows and flow-units. Each flow group is made up of from one to five petrographically similar flows that erupted from common source areas during periods of less than 200 years. Sedimentary interbeds consist of fluvial, lacustrine, and wind-blown deposits of clay, silt, sand, and gravel that accumulated during periods of volcanic inactivity ranging from thousands to hundreds of thousands of years. Flows and sediment are unsaturated to a depth of about 600 ft. Flows and sediment below a depth of 600 ft are saturated and make up the uppermost part of the Snake River Plain aquifer. The areal extent of flow groups and interbeds was determined from well cuttings, cores, geophysical logs, potassium-argon ages, and geomagnetic properties. Stratigraphical control was provided by four sequential basalt flows near the base of the unsaturated zone that have reversed geomagnetic polarity and high emission of natural gamma radiation compared to other flows. Natural gamma logs were used as a primary correlation tool. Natural-gamma emissions, which are generally uniform in related, petrographically similar flows, increase or decrease between petrographically dissimilar flows of different age and source. (USGS)
W90-03876

CONSTRUCTION DATA AND RETRIEVAL PROCEDURES FOR SELECTED WELLS DRILLED FROM 1985 THROUGH 1987 AT OAK RIDGE NATIONAL LABORATORY, TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
H. H. Zehner.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-61, September 1988. 95p, 1 fig, 1 tab, 1 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Wells, *Well data, *Data storage and retrieval, *Piezometers, *Radioactive waste disposal, *Tennessee, Aquifers, Conasauga Group.

Twenty-eight wells were constructed by the U. S. Geological Survey for use in describing the groundwater flow system in Melton Valley, at the Oak Ridge National Laboratory in eastern Tennessee. The wells were installed at 18 locations in Melton Valley and along the Clinch River during the period 1985 through 1987. During the same period, 19 wells were constructed by Oak Ridge National Laboratory at 7 locations in or near radioactive-waste burial grounds in Melton Valley. Construction data for all 47 wells are in the U.S. Geological Survey Groundwater Site Inventory data system, where information is also stored for 450 wells that were completed at the laboratory in earlier years. The data can be electronically retrieved by personnel who have access to the U.S. Geological Survey Prime computer located in Nashville, Tennessee, and retrieval procedures are given in the report. (USGS)
W90-03878

HYDROGEOLOGY, BRACKISH-WATER OCCURRENCE, AND SIMULATION OF FLOW AND BRACKISH-WATER MOVEMENT IN THE AQUIA AQUIFER IN THE KENT ISLAND AREA, MARYLAND.
Maryland Geological Survey, Baltimore.
D. D. Drummond.
Available from Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21218. Maryland Geological Survey Report of Investigations No. 51, 1988. 131p, 63 fig, 11 tab, 35 ref, append.

Descriptors: *Model studies, *Saline-freshwater interfaces, *Aquifer systems, *Hydrologic models, *Brackish water, *Saline water intrusion, *Aquia Aquifer, *Maryland, Solute transport, Aquifer characteristics, Potentiometric level, Kent Island.

A study was conducted to investigate the hydrogeology of the Aquia aquifer in the Kent Island area, Maryland. The occurrence of brackish-water in the Aquia aquifer is specifically addressed. The Aquia aquifer is a fine-grained to medium-grained glauconitic sand, containing layers of clayey sand, layers indurated by calcite cement, and abundant shell material. Brackish water occurs in the Aquia aquifer along the Chesapeake Bay shore from the northernmost tip of the island (Love Point) at least as far south as Prices Creek. A two-layer areal flow model was developed to simulate the response of water levels to projected pumpage in the Aquia aquifer. A simulation of the most probable estimate of future pumpage indicates an additional 5 ft of drawdown from the 1984 potentiometric surface by the year 2005 on parts of Kent Island. The greatest declines occur on the eastern part of the island near Grasonville. A cross-sectional solute-transport model was developed to estimate the movement of brackish water in response to projected pumpage amounts. Model results indicate that the freshwater/brackish-water interface will move about 440 ft inland during the 21-year simulation period (1984-2005) with the most probable future pumpage. (USGS)
W90-03879

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, APRIL 9, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
S. J. Owen-Joyce.
Available from Books and Open File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-377, July 1989. 14p, 3 fig, 2 tab.

Descriptors: *Remote sensing, *Agriculture, *Data collections, *Arizona, Photography, Cropland.

Field conditions were documented during the SPOT satellite overpass of the Maricopa Agricultural Center, Pinal County, Arizona, on April 9, 1989. Crop types were mapped and photographed for each demonstration farm field, and irrigation, cultivation, and orientation of rows are described. Field and photographic descriptions are presented in tabular and graphic form. (USGS)
W90-03880

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, JUNE 16, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
S. J. Owen-Joyce.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-392, 1989. 11p, 3 fig, 2 tab, 2 ref.

Descriptors: *Remote sensing, *Agriculture, *Data collections, *Arizona, Photography, Cropland.

Field conditions were documented during the SPOT satellite overpass of the Maricopa Agricultural Center, Pinal County, Arizona, on June 16, 1989. Crop types were mapped and photographed for each demonstration farm field, and irrigation, cultivation, and orientation of rows are described. Field and photographic descriptions are presented in tabular and graphic form. (USGS)
W90-03881

GEOHYDROLOGY OF THE ESCONDIDO HYDROLOGIC SUBAREA, SAN DIEGO COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
L. R. Woolfenden.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4223, 1989. 21p, 7 fig, 3 tab, 10 ref.

Descriptors: *Water resources development, *California, *Groundwater level, *Groundwater movement, *Water quality, San Diego, Dissolved solids, Nitrates, Escondido Hydrologic Subarea.

The San Diego region of California is undergoing rapid growth with a corresponding increase in the demand for water. To update the basin plan developed in 1975 by the California Regional Water Quality Control Board, San Diego Region, water-level and water quality data for the 44-sq mi Escondido hydrologic subarea were collected and analyzed. Water-level measurements indicate that groundwater in most of the subarea was within 20 ft of land surface. Groundwater generally moves from the weathered crystalline rocks on hillsides into the alluvium. Groundwater moves from north to south in Reidy Canyon and from east to west in the alluvium along Escondido Creek. Water from all 20 wells sampled in 1987 had dissolved-solids concentrations greater than the U.S. Environmental Protection Agency recommended limit of 500 mg/L; concentrations ranged from 720 to 4,500 mg/L. Nitrate (as nitrogen) concentrations ranged from 1.1 to 86 mg/L. Water from 14 of the 20 wells had nitrate (as nitrogen) concentrations greater than the U.S. Environmental Agency recommended limit of 10 mg/L. (USGS)
W90-03882

PROGRESS REPORT ON THE GROUNDWATER, SURFACE-WATER, AND QUALITY-OF-WATER MONITORING PROGRAM, BLACK MESA AREA, NORTHEASTERN ARIZONA--1988-89.
Geological Survey, Flagstaff, AZ. Water Resources Div.
R. J. Hart, and J. P. Sottilare.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-383, 1989. 33p, 7 fig, 8 tab, 10 ref.

Descriptors: *Groundwater, *Coal mine effects, *Water level, *Water quality, *Arizona, *Black Mesa, Navajo Indian Reservation, Hopi Indian Reservation, N Aquifer.

The Black Mesa monitoring program in Arizona is designed to determine long-term effects on the water resources of the area resulting from withdrawals of groundwater from the N aquifer by the strip-mining operation of Peabody Coal Company. Withdrawals by Peabody Coal Company increased from 95 acre-ft in 1968 to 4,090 acre-ft in 1988. The N aquifer is an important source of water in the 5,400-sq-mi Black Mesa area on the Navajo and Hopi Indian Reservations. Water levels in the confined area of the aquifer declined as much as 19.7 ft near Low Mountain from 1988 to 1989. Part of the decline in the measured municipal wells may be due to local pumping. During 1965-88, water levels in wells that tap the unconfined area of the aquifer have not declined significantly and have risen in many areas. Chemical analysis indicate no significant changes in the quality of water from wells that tap the N aquifer or from springs that discharge from several stratigraphic units, including the N aquifer, since pumping began at the mine. The groundwater flow model developed for the study area in 1988 was updated using pumpage data for 1985-88. The model simulated a steady decline in water levels in observations wells developed in areas of unconfined groundwater. Measured water levels in these wells did not show this trend but indicated that water levels remained the same or increased. The model accurately simulated water levels in most observation wells developed in areas of confined groundwater. (USGS)
W90-03883

EFFECTS OF THREE HIGHWAY-RUNOFF DETENTION METHODS ON WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM IN CENTRAL FLORIDA.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-03884

HYDROLOGY OF THE PROSPECTOR SQUARE AREA, SUMMIT COUNTY, UTAH.
Geological Survey, Salt Lake City, UT. Water Resources Div.
J. L. Mason.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4156, 1989. 75p, 8 fig, 10 tab, 9 ref.

Descriptors: *Geohydrology, *Utah, *Groundwater movement, *Water pollution sources, *Mine wastes, Groundwater, Surface water, Water quality, Aquifer characteristics, Metals.

The Silver Creek tailings site is in Prospector Square, a commercial development and residential community in Summit County, Utah. This study assessed the presence of metals and the movement of groundwater in the unconsolidated valley-fill and consolidated-rock aquifers underlying the tailings. The unconsolidated valley fill is a poorly sorted mixture of clay, silt, sand, and gravel, with intermittent layers of clay. The hydraulic conductivity, estimated on the basis of slug tests, ranged from 1 to 14 ft/day. An aquifer-interference test indicated that water in the valley fill underlying the tailings site did not move toward the pumped municipal well completed in the consolidated-rock aquifer. Concentrations of dissolved and suspended cadmium, manganese, and zinc were greater than background in surface water only during low-flow conditions. Concentrations of suspended iron and lead were greater than background concentrations upstream from the tailings site, but concentrations decreased progressively downstream and during later sampling rounds. Concentrations of dissolved cadmium, managanese, and zinc were greater than background concentrations in water from six wells and one drain. Dissolved arsenic and lead were detected in water from a well downgradient from Prospector Square, but were not detected in water from any of the other wells. Concentrations of all selected metals detected in stream-sediment samples, were detected in similar concentrations in tailings samples. Concentrations of metals in surface and groundwater could increase if the pH of the water decreases substantially from the present (1988) values of about 7 (neutral). (USGS)
W90-03885

ESTIMATION OF THE RECHARGE AREA OF A PUMPED, STRATIFIED-DRIFT AQUIFER IN CONNECTICUT BY SIMULATION MODELING.
Geological Survey, Hartford, CT. Water Resources Div.
D. L. Mazzaferro.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4124, 1989. 100p, 13 fig, 10 tab, 24 ref, append.

Descriptors: *Model studies, *Recharge, *Hydrologic models, *Groundwater basins, *Groundwater movement, *Glacial aquifers, *Recharge basins, *Connecticut, Groundwater management, Alluvial aquifers, Aquifer management, Water quality management, Hypothetical aquifer model, Farmington.

Groundwater quality management plans in Connecticut require information about the size and shape of recharge areas that contribute flow to pumping centers in extensive, stratified-drift aquifers. Flow models of a hypothetical aquifer, and a stratified-drift aquifer in Farmington are used to evaluate how contributing areas change in response to variations in recharge and hydraulic conductivity. A series of simulations of a hypothetical aquifer model were made during which average annual recharge rates of 0, 15, 25, and 35 inches were combined with aquifer hydraulic conductivity values of 25, 75, and 225 ft/day. Under steady-state conditions, and a withdrawal rate of 1.2 million gal/day, the size of the contributing recharge area ranges from 0.16 to 0.75 sq mi as recharge from precipitation and average aquifer hydraulic conductivity range from highest to lowest values. Three simulations of the Farmington aquifer model were made: they assumed steady-state conditions, a withdrawal rate of 2.8 million gal/day, and combinations of recharge and aquifer hydraulic conductivity that represented highest, average and lowest rates. The size of the contributing recharge area, under these conditions, ranges from 0.89 to 1.94 sq mi. (USGS)
W90-03886

HYDROGEOLOGICAL AND HYDROGEOCHEMICAL CHARACTERIZATION AND IMPLICATIONS FOR CONSUMPTIVE GROUNDWATER USE OF A LARGE GLACIAL-DRIFT AQUIFER SYSTEM IN SOUTHWEST MICHIGAN.
Western Michigan Univ., Kalamazoo. Center for Water Research.
For primary bibliographic entry see Field 2A.
W90-03891

GROUNDWATER CHEMISTRY AND PALAEORECHARGE IN THE AMADEUS BASIN, CENTRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia). Div. of Continental Geology.
G. Jacobson, G. E. Calf, J. Jankowski, and P. S. McDonald.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 237-266, August 1989. 15 fig, 10 tab, 30 ref.

Descriptors: *Groundwater recharge, *Water chemistry, *Paleohydrology, *Australia, *Geohydrology, *Geochemistry, Surface-groundwater relations, Percolation, Sand aquifers, Aquifers, Geologic history, Geologic time.

Carbon isotope chemistry indicates episodic palaeorecharge of groundwater in the arid Amadeus

Basin, central Australia. In this hydrogeologically complex region, groundwater has been recharged by three important mechanisms: direct infiltration of rainwater though sand dune cover or fissures in calcrete; through river bed sands following floods; and through joints in bedrock outcrops. Modern and Holocene groundwaters (0-5000 years B.P.) are found in the unconfined calcrete and sand dune aquifers that have evolved hydrochemically to Cl-SO4-Na waters with Ca and Mg, as a result of evaporative concentration. Holocene groundwaters (3-10,000 years B.P.) have been dated in river bed recharge situations; these groundwaters are mainly of the HCO3-Cl-Na type, with Ca and Mg, and preserve the hydrochemical signature of the flood recharge waters. Most groundwater sampled in the folded and jointed rocks of the Basin has a low modern 14 C content and was recharged in the Holocene and late Pleistocene (12-32,000 years B.P.). These waters are intermediate in their ionic composition, covering a spectrum between the HCO3-Cl-Na and Cl-SO4-Na types; solution is the dominant process in their hydrochemical evolution. Stable isotope signatures and derived parameters indicate that the intensity of rainfall is an important factor in the evolution of arid-zone groundwaters. Modern recharge is limited implying that projected large scale groundwater development in this region will use an effectively nonrenewable resource and should be managed accordingly. (Author's abstract)
W90-03905

GEOHYDROLOGICAL RESEARCH IN RELATION TO RADIOACTIVE WASTE DISPOSAL IN AN AGRILLACEOUS FORMATION.
Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
J. Patyn, E. Ledoux, and A. Bonne.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 267-285, August 1989. 9 fig, 3 tab, 22 ref.

Descriptors: *Geohydrology, *Clays, *Underground waste disposal, *Radioactive wastes, *Radioactive waste disposal, *Waste disposal, Aquifers, Confined aquifers, Belgium, Hydrodynamics.

Since 1974, the Belgian Nuclear Research Establishment (SCK/CEN) at Mol has been studying the suitability of the Boom clay formation as a potential host formation for wastes arising from the Belgian nuclear power production. The method developed to evaluate, from the point of view of the regional hydrology, the capacity of the Boom clays for confining radioactive waste products, is presented. This method consists of four successive steps: (1) a reconnaissance of the geological and hydrogeological structure; (2) the development of a numerical model to interpret the field observations; (3) the construction of an appropriate migration model that uses the results obtained by the hydrodynamic model; and finally (4) the simulation of the consequences of possible changes in the hydrogeological system due to natural geological evolution. The analysis also stresses the role of confining layers in multilayered aquifer systems and the importance of leakage flow on a regional scale. (Author's abstract)
W90-03906

SOLUTION OF THE NONLINEAR BOUSSINESQ EQUATION FOR PHREATIC FLOW USING AN INTEGRAL BALANCE APPROACH.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 7C.
W90-03909

PHYSICS VERSUS MATHEMATICS IN GROUNDWATER FLOW: A PHYSICAL EXPLANATION OF THE MINIMUM THEOREM IN FINITE ELEMENT CALCULATIONS.
For primary bibliographic entry see Field 7C.
W90-03913

MICROBIAL DEGRADATION OF BENZENE AND TOLUENE IN GROUNDWATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-03937

SOME NEW DEVELOPMENTS IN HYDROLOGICAL MODELLING.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 5B.
W90-03966

MODEL FOR THE RELATIONSHIP BETWEEN THE HYDRAULIC CONDUCTIVITY AND PRIMARY SEDIMENTARY STRUCTURES OF TILL.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Geology.
M. R. Nyborg.
Nordic Hydrology NOHYBB, Vol. 20, No. 3, p 137-152, 1989. 10 fig, 5 tab, 18 ref.

Descriptors: *Groundwater movement, *Till, *Glacial soils, *Glacial aquifers, *Hydraulic conductivity, *Soil properties, Capillary pressure, Porosity, Mathematical models, Correlation analysis, Permeameters.

The relationships between saturated hydraulic conductivity, porosity, and micro-structure of undisturbed lodgement till samples were investigated. Thirty-five measurements with a constant-head laboratory permeameter were the basis for the discussion. All the measurements were made on undisturbed till samples. To minimize the effects of soil forming processes and to obtain the most homogeneous conditions, all sampling was done in the C horizon. Samples were approximately 300 cu cm. Porosity data were derived from capillary pressure curves. A model of how flow direction and long-axis orientations of elongated grains relate to the saturated hydraulic conductivity is presented. For an unsorted sediment, such factors as grain size are concluded to be of minor importance for the hydraulic conductivity, whereas structural properties seem to be more important. This result can be explained in two ways: (1) as a result of the directional relations between sorted lenses and bands having higher permeability and the flow route through the sample or (2) because of a more continuous pore pattern parallel to the grain orientation. The hydraulic conductivity takes on a directional property, being smaller in directions normal to the structural long-axis orientation than in directions parallel to the orientation. A study of the effective porosity versus hydraulic conductivity showed weak correlation. (Author's abstract)
W90-03983

STUDIES OF THE GROUNDWATER HAZARDS OF DEPOSITED FLY ASH FROM COAL-FIRED POWERPLANTS: PART II. INVESTIGATION OF ELUTION CHARACTERISTICS OF SOME MAJOR AND TRACE ELEMENTS FOR MULTIPLE EXTRACTIONS OF COAL FLY ASH UNDER VARIOUS SCENARIOS (ZUR UNTERSUCHUNG DER GRUNDWASSERGEFAHRDUNG DURCH ABGELAGERTEN FLUGSTAUB AUS STEINKOHLEKRAFTWERKEN: II. DAS AUSLAUGVERHALTEN EINIGER HAUPT- UND PURENELEMENTE VON FLUGSTAUB BEI MEHRFACHAUSLAUGUNGNEN FUER VERSCHIEDENE SZENARIEN).
Bremen Univ. (Germany, F.R.). Fachbereich Chemie/Biologie.
For primary bibliographic entry see Field 5B.
W90-04001

NITRATE REDUCTION IN A GROUNDWATER MICROCOSM DETERMINED BY 15N GAS CHROMATOGRAPHY-MASS SPECTROMETRY.
Lund Univ. (Sweden). Dept. of Ecology.
For primary bibliographic entry see Field 5B.
W90-04032

VOLUMETRIC APPROACH TO MULTIAQUIFER AND HORIZONTAL FRACTURE WELLS.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
For primary bibliographic entry see Field 8B.
W90-04123

RADIAL FLOW IN VERTICALLY GRADED HYDRAULIC CONDUCTIVITY AQUIFERS.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
Z. Sen.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1667-1682, December 1989. 5 fig, 1 tab, 26 ref.

Descriptors: *Aquifers, *Hydraulic conductivity, *Groundwater movement, *Type curves, *Laminar flow.

Type curve expressions are derived analytically for drawdowns around a fully penetrating well in vertically graded hydraulic conductivity aquifers. A linear increase in the hydraulic conductivity with depth is adopted in this paper. Solution of the relevant groundwater movement equations are achieved by the application of the Boltzmann transformation individually for the continuity and laminar flow law equations. Necessary type curves are presented for determining the aquifer parameters from an aquifer test performed in the field. The analytical results show that the conventional Theis and Jacob methods are not applicable in the cases of vertically graded hydraulic conductivity aquifers. In addition, a straight line method is proposed for the late time-drawdown data. However, both type-curve and straight-line procedures developed in the paper yield the Theis and Jacob method equivalents, respectively. The application of the methodology is given for fissured and fractured hard-rock aquifer test data in the field. (Author's abstract)
W90-04124

GROUND WATER RESOURCES OF THE TAURANGA GROUP SEDIMENTS IN THE HAMILTON BASIN, NORTH ISLAND, NEW ZEALAND.
Waikato Catchment Board, Hamilton (New Zealand). Resource Hydrology Unit.
R. A. Petch, and T. W. Marshall.
Journal of Hydrology (New Zealand) JLHYAD, Vol. 27, No. 2, p 81-98, 1988. 8 fig, 5 tab, 18 ref.

Descriptors: *Water resources development, *Groundwater resources, *Aquifers, *Surface water availability, *Groundwater availability, *New Zealand, Piezometry, Rainfall infiltration, Groundwater recharge, Geology, Drainage patterns, Isotopic analysis, Hydraulic conductivity, Hamilton Basin, Tauranga Group Sediments.

The Tauranga Group sediments contain the most important and widely distributed aquifers in the Hamilton Basin. Among these sediments the most productive aquifers are well-sorted, coarse sand and gravel deposits. However, poor hydraulic characteristics are common because the sediments are often poorly sorted, and high-yielding zones are interspersed with lenses of less permeable silts, clays and peats. The spatial variation of the regional piezometric surface and the patterns of groundwater flow closely follow the surface topography in the Basin. The depth to the piezometric surface varies from a few meters below the undissected lowland plains to 30 m adjacent to incised stream channels. Vertical piezometric gradients and isotopic analyses suggest most groundwater flow is restricted to the upper 30 m of the Tauranga Group sediments. Recharge occurs from rainfall infiltration over the undissected lowland plains; groundwater discharge is by effluent flow to the incised stream networks. The net variation in aquifer storage observed during this study (9 mm) suggests recharge to the Tauranga Group sediments equals discharge from them and implies no subterranean leakage from the Basin. The implied equilibrium between aquifer recharge and discharge means use of groundwater will be associat-

ed with a reduction in stream flow. Thus, the availability of water resources in the Tauranga Group sediments depends on the joint management of groundwater and surface water resources. (Author's abstract)
W90-04130

ACCURATE ESTIMATION OF CONDUCTIVITY OF WATER FROM GEOELECTRIC MEASUREMENT--A NEW WAY TO CORRECT FOR CLAY.
California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
S. K. Park, and S. K. Dickey.
Groundwater GRWAAP, Vol. 27, No. 6, p 786-792, November-December 1989. 6 fig, 2 tab, 11 ref.

Descriptors: *Geoelectric studies, *Conductivity, *Groundwater, *Geophysics, Clays, Archies law, Porosity, Wells.

A new way to correct estimating of solution conductivity for the effects of clay in a rock is proposed. The bulk electrical conductivity of a rock is dependent on its porosity, the conductivity of the pore fluid, and its clay content. Archie's law relates the bulk electrical conductivity to the first two factors only. The third factor, clay, enhances a rock's conductivity through surface conduction, and simple application of Archie's law will lead to overestimates of the solution conductivity. The enhancement due to clay can be estimated from measurements of induced polarization, however, and the bulk conductivity of the rock can be corrected. This correction will then lead to a more accurate estimate of the solution conductivity. Both resistivity and induced polarization can be measured by geophysical techniques. Interpretations of geophysical data are inherently nonunique unless wells are correlated with the data. The method proposed requires calibration with subsurface samples from at least one location. The method tested has been corrected for clay in an area already sampled by monitoring wells. The corrections lead to substantial improvements in the correlation between solution conductivities from wells and from geophysical measurements. A replacement of wells with geophysical soundings is not proposed. Rather, the geophysical measurements, which are obtained at a fraction of the cost of a well, can be used to site wells and minimize the amount of drilling needed. (Author's abstract)
W90-04157

GROUND-WATER ASSESSMENT OF SINAI, EGYPT.
Geraghty and Miller, Inc., Hackensack, NJ.
A. C. Mills, and A. Shata.
Groundwater GRWAAP, Vol. 27, No. 6, p 793-792, November-December 1989. 7 fig, 4 tab, 21 ref.

Descriptors: *Groundwater resources, *Sinai, *Egypt, *Groundwater quality, *Groundwater, Wells, Geology, Dissolved solids, Groundwater movement, Groundwater availability.

A groundwater assessment of Sinai, Egypt, was performed from 1980 to 1983 as a part of the Sinai Development Study. The basic data included existing stratigraphic data from 69 wells and 57 columnar sections, and hydrologic data for 716 water points (wells and springs). Statistical analysis of the data for total dissolved solids (TDS) and for yields from the water points by groundwater province and by geologic unit showed that the Southern Mountain Province generally has the best quality groundwater and the Suez Rift Province the worst. Among all the geologic units, the crystalline rock, the Middle Cretaceous sequence, and the Quaternary deposits yield water of the lowest total dissolved solids. The mean TDS value of groundwater from all water points in Sinai for which data were available is 2,800 mg/L. Of all the geologic units, the highest mean yield (200 cu m/day, or about 37 gpm) was from Quaternary deposits in the vicinity of El Arish in the north and in the El Qaa plain along the southwest coast. Regional groundwater flow in the sedimentary aquifers, such as the Lower Cretaceous (and older) sandstone, tends to be strongly influenced by large-scale folds and faults. In this aquifer, regional flow occurs generally northward and northeastward toward the Arava valley and the Dead Sea in Israel, but another component of flow occurs toward the Gulf of Suez on the western side. (Author's abstract)
W90-04158

GEOCHEMICAL VARIATIONS IN A CORE OF HYDROGEOLOGIC UNITS NEAR FREEHOLD, NEW JERSEY.
Geological Survey, Trenton, NJ. Water Resources Div.
A. A. Pucci, and J. P. Owens.
Groundwater GRWAAP, Vol. 27, No. 6, p 802-812, November-December 1989. 7 fig, 1 tab, 29 ref.

Descriptors: *Water chemistry, *Geochemistry, *New Jersey, *Groundwater quality, *Aquifers, Cores, Interstitial water, Sulfates, Anions, Cations, Geology.

Solutes were determined for 26 pore-water samples extracted from Tertiary and Cretaceous core material from a 1,320-ft-deep test borehole at Freehold, New Jersey. The cored materials are sediments that form a multilayered aquifer system of seven aquifers and eight confining units in the New Jersey Coastal Plain. The sediments are of marine origin in the upper 650 ft of the core and primarily non-marine below 650 ft. Total concentrations of silica and major anions (SO_4(--) and Cl-) and cations (Ca+2, Mg+2, total Fe, Mn+2, Na+, and K+) in the pore-water samples varied with depth. Three core intervals are defined by water-chemistry variations, the environment of deposition (marine-or nonmarine), and the degree of alteration (weathered or unweathered) of the units. Calcium magnesium, sulfate, and total-ion concentrations were greater in the midcore (unweathered marine) interval than in the upper (weathered marine) and lower (fluviodeltaic-silicate) intervals of the core. Generally, pore-water chemical types in confining units were distinct from those found in aquifers-particularly in the midcore interval. In this interval, observed variations in pore-water chemistry in part reflect carbonate dissolution and cation exchange reactions common in Coastal Plain sediments. However, high concentrations of sulfate in unweathered marine sediments indicate novel processes may be important factors influencing pore-water chemistry in confining units. (Author's abstract)
W90-04159

IONIC COMPOSITION OF VADOSE ZONE WATER IN AN ARID REGION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 5B.
W90-04160

AEROBIC BIODEGRADATION OF BENZENE, TOLUENE AND XYLENE IN A SANDY AQUIFER--DATA ANALYSIS AND COMPUTER MODELING.
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5B.
W90-04161

EXPERT OPINION AND GROUND-WATER QUALITY PROTECTION: THE CASE OF NITRATE IN DRINKING WATER.
Iowa Univ., Iowa City. Dept. of Geography.
For primary bibliographic entry see Field 5G.
W90-04162

EXPERIMENTAL RESEARCH ON PERMEABILITY OF GRANULAR MEDIA.
Shaanxi Inst. of Mechanical Engineering, Xian (China). School of Water Resources and Hydroelectric Engineering.
E. H. Zhao.
Groundwater GRWAAP, Vol. 27, No. 6, p 848-854, November-December 1989. 5 fig, 6 tab, 9 ref.

Descriptors: *Groundwater hydraulics, *Saturated flow, *Hydraulic conductivity, *Permeability, *Fluid mechanics, Granular media, Permeability coefficient, Sieve analysis, Density, Mathematical equations.

The coefficient of permeability or hydraulic conductivity is a basic parameter of a granular media. It is difficult to determine the coefficient of permeability because it depends on many factors. According to experiments and analysis, it is thought that permeability of a granular media results from the unified effect of an external factor--the hydraulic gradient, and internal factors--properties of the granular media itself and the fluid; therefore, the permeability of a granular media can be determined by a sieve analysis and physical characteristics of the fluid. Based on theoretical analysis and experiments, a unified expression to calculate the coefficient of permeability of a granular media is advanced. The precision of the formula meets practical requirements based on inspection of experimental data. The formula uses the field coefficient of permeability of a granular media (L/T); a nonlinear coefficient of about 3-6; the specific density of the fluid; the intrinsic permeability coefficient of a granular media; the coefficient of dynamic viscosity of fluid; an index of flow patterns with a value ranging from 1-2; and the fluid density. The range of validity of the proposed formula is uncemented granular media. (Author's abstract)
W90-04163

GEOSTATISTICAL ESTIMATION OF HYDRAULIC HEAD GRADIENTS.
Stanford Univ., CA. Dept. of Civil Engineering.
R. D. Philip, and P. K. Kitanidis.
Groundwater GRWAAP, Vol. 27, No. 6, p 855-865, November-December 1989. 13 fig, 8 ref. USGS Dept. of Interior No. 14-08-0001-G1491.

Descriptors: *Geostatistics, *Statistical methods, *Groundwater movement, *Geohydrology, *Hydraulic properties, *Texas, *Aquifers, Hydraulic head, Model studies, Kriging, Spatial variability.

A best linear unbiased estimator which may be used to directly estimate gradients of hydraulic head from scattered measurements of head has been derived. The hydraulic head is broken into continuous and discontinuous components. The continuous portion represents the large-scale variability of head. The discontinuous portion, which represents random measurement error and small-scale variability, is filtered from the measurements. The technique is applied to measurements of hydraulic head in the Wolfcamp aquifer in northern Texas. Experimental variograms are used to investigate the isotropy and stationarity of the random field describing head. Head is assumed to be locally stationary (within neighborhoods of 50 miles), and a Gaussian variogram model is fitted to the experimental variogram. Model validation tests are used to check the assumed model of spatial variability. Moving neighborhood kriging with a 50-mile radius is used to estimate hydraulic head and head gradient on a fine mesh over the area of Wolfcamp aquifer. Kriging is a powerful estimation technique whose worth goes beyond just interpolating and extrapolating values at new locations from measurements. (Author's abstract)
W90-04164

COMPUTER NOTES--ON ANALYSIS OF STEP-DRAWDOWN DATA.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 7C.
W90-04166

TESTING FOR TREND IN LAKE AND GROUND WATER QUALITY TIME SERIES.
Colorado State Univ., Fort Collins. Dept. of Statistics.
For primary bibliographic entry see Field 5A.
W90-04167

ESTIMATION OF RECHARGE FROM A RESERVOIR USING TWO WATER BUDGET MODELS.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
F. F. Al-Muttair, and A. S. Al-Turbak.
Water Resources Bulletin WARBAQ, Vol. 25, No.

4, p 727-732, August 1989. 3 fig, 2 tab, 10 ref.

Descriptors: *Surface-groundwater relations, *Groundwater recharge, *Reservoirs, *Saudi Arabia, Model studies, Hydrologic budget, Data acquisition, Water depth, Volume, Observation wells.

Reservoir water levels, observation well data, and meteorological parameters were collected at a recharge dam site in Central Saudi Arabia. This data, along with other information on the reservoir and the underlying aquifer, were used to estimate the amounts of recharge through the reservoir bed by applying two water budget models. The first is a water budget model for the reservoir only, while the second is for an aquifer reach extending upstream and downstream from the reservoir. The choice as to which model to use depends on the type of data available. The reservoir water budget model mainly requires depth versus volume and depth versus surface area curves, daily values of water levels in the reservoir, and estimation of daily evaporation from the lake. The aquifer reach water budget model requires geophysical cross-sections (drill holes or driller logs can also be used), observation well data, and an estimate of the aquifer hydraulic conductivity. The reservoir water budget model is easier to use and the data needed for it is probably easier to collect than the other model. The aquifer reach water budget model, however, has the advantage of showing how the subsurface inflow, outflow, and storage within the reach change throughout the season. This is helpful in studying the variability of recharge process from reservoirs and how important the contribution of each component is to that process. (Author's abstract)
W90-04168

IRRIGATION DEVELOPMENT AND MANAGEMENT ALTERNATIVES OF A DOLOMITE AQUIFER IN NORTHEASTERN ILLINOIS.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 3F.
W90-04213

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLUME, CROSS-SECTION, AND RECHARGE.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
For primary bibliographic entry see Field 5B.
W90-04217

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLASM AND RANDOM WALK.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
For primary bibliographic entry see Field 5B.
W90-04218

VIRGINIA'S GROUNDWATER.
Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. 101p. Edited by Jacob H. Kahn.

Descriptors: *Virginia, *Groundwater resources, *Conferences, *Groundwater quality, *Groundwater pollution, *Groundwater management, State jurisdiction, Regulations, Water pollution control.

The symposium proceedings presents papers and discussions on four major topics: (1) responses to groundwater contamination, (2) preventing groundwater contamination, (3) managing groundwater quality, and (4) protecting groundwater in Virginia. In addition, appendices provide selected provisions to Virginia law relating to groundwater quality. (See W90-04222 thru W90-04233) (Lantz-PTT)
W90-04221

UNDERSTANDING THE PROBLEM OF GROUNDWATER CONTAMINATION.
CorSTAR Research, Inc., Bethesda, MD.
For primary bibliographic entry see Field 5B.
W90-04222

REMEDIES AT EXISTING FACILITIES.
For primary bibliographic entry see Field 5G.
W90-04223

REMEDIAL METHODS FOR POLLUTED AQUIFERS.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 5G.
W90-04224

DEVELOPING ALTERNATIVES TO LANDFILLS.
For primary bibliographic entry see Field 5E.
W90-04225

NEW JERSEY'S PROGRAM.
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 5G.
W90-04227

LOCAL OPTIONS FOR GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W90-04228

CLASSIFYING AQUIFERS.
P. L. Magnuson.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 67-75, 2 fig, 2 tab, 6 ref.

Descriptors: *Water quality management, *Groundwater classification, *Aquifer classification, *Aquifers, *Classification, *Regulations, *Groundwater quality, Public policy, State jurisdiction, Geohydrology, Social aspects, Groundwater management, Land use, Mapping.

Groundwater classification is a tool available to states for implementing their groundwater protection programs. It is most appropriately employed by states that embrace the policy that all groundwaters are not of equal value. Ten states and one territory have adopted groundwater classification systems. The classification process begins with state policy formulation. Issues to be addressed range from groundwater use and antidegradation to growth and economic policies. Classification criteria can range from use and existing quality to geohydrologic and socioeconomic factors. Classification systems can be simple or complex, depending upon the availability of data and the complexity of the aquifer system. States should perform a thorough review of existing programs and available resources before selecting a classification approach. Where land use controls and other nonstructural measures are to be the primary mechanisms for protecting groundwater quality, nonnumerical classification systems may be more appropriate than quantitative approaches (which rely on numerical criteria, effluent limitation, etc.). Data gaps and complex hydrologic systems may limit a state's ability to implement its classification system in one step. Instead, the state may need to follow a phased approach. Policy development and classification criteria may be adopted as the first step. Mapping and classification of individual aquifer segments then may be carried out as data become available. (See also W90-04221) (Lantz-PTT)
W90-04229

ELEMENTS OF A GROUNDWATER MANAGEMENT PROGRAM.
ICF, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W90-04230

PROGRAMS TO PROTECT GROUNDWATER IN VIRGINIA.
Virginia State Water Control Board, Richmond.
For primary bibliographic entry see Field 5G.
W90-04233

EVALUATION OF CONTROL CHART METHODOLOGIES FOR RCRA WASTE SITES.
Nevada Univ., Las Vegas. Environmental Research Center.
For primary bibliographic entry see Field 5G.
W90-04247

WATER SUPPLY AT LOS ALAMOS: CURRENT STATUS OF WELLS AND FUTURE WATER SUPPLY.
Los Alamos National Lab., NM.
W. D. Purtymun, and A. K. Stoker.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-002109. Price codes: A03 in paper copy, A01 in microfiche. Report No. LA-11332-MS, August 1988. 39p, 15 fig, 15 tab, 30 ref. DOE Contract W-7405-ENG-36.

Descriptors: *Groundwater resources, *Water resources development, *Water supply, *Well restoration, *Wells, *Los Alamos, *Maintenance, New Mexico, Groundwater quality, Groundwater management, Pumps, Groundwater mining.

The municipal and industrial use of groundwater at the Los Alamos National Laboratory and Los Alamos County was about 1.5 billion gallons during 1986. From a total of 19 wells that range in age from 5 to 41 years, the water was pumped from 3 well fields. The life expectancy of a well in the area ranges from 30 to 50 years, dependent on the well construction and rate of corrosion of the casing and screen. Twelve of the wells are more than 30-years old and, of these, four cannot be used for production, three because of well damage and one because the quality of water is not suitable for use. Eight of the twelve oldest wells are likely to be unsuitable for use in the next 10 years because of well deterioration and failure. The remaining 7 wells include 2 that are likely to fail in the next 20 years. Five of the younger wells in the Pajarito well field are in good condition and should serve for another two or three decades. The program of maintenance and rehabilitation of pumps and wells has extended production capabilities for short periods of time. Pumps may be effectively repaired or replaced; however, rehabilitation of the well is only a short-term correction to increase the yield before it starts to decline again. The two main factors that prevent successful well rehabilitation are: (1) chemicals precipitated in the gravel pack and screen restrict or reduce the entrance of water to the well, which reduces the yield of the well, and (2) the screen and casing become corroded to a point of losing structural strength and subsequent failure allows the gravel pack and formation sand to enter the well. Both factors are due to long-term use and result in extensive damage to the pump and reduce the depth of the well, which in turn causes the yield to decline. It is essential to implement a program to replace wells that have failed or will fail in the next 10 years to ensure a continued and reliable water supply. (Author's abstract)
W90-04259

MINNESOTA WATER: A GEOGRAPHICAL PERSPECTIVE.
Minnesota Univ., Minneapolis. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-04266

GEOLOGY, HYDROLOGY AND HISTORY OF THE WASHINGTON, D.C. AREA.
American Geological Inst., Alexandria, VA.
For primary bibliographic entry see Field 2A.
W90-04271

WASHINGTON, D.C.'S VANISHING SPRINGS AND WATERWAYS.
For primary bibliographic entry see Field 4C.
W90-04272

APPLICATIONS OF THE METHOD OF FUNDAMENTAL SOLUTIONS IN WATER RESOURCES.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
For primary bibliographic entry see Field 8B.
W90-04285

SIMILARITIES AND DIFFERENCES IN THE NATURE OF GROUND AND SURFACE WATER DATA AND THE IMPLICATIONS FOR DESIGNING PERSONAL COMPUTERS DATA SYSTEMS.
Institute of Hydrology, Wallingford (England).
J. W. Finch, and C. S. Green.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 341-351, 5 fig.

Descriptors: *Databases, *Computer programs, *Computer-aided engineering, *Data acquisition, *Data processing, *Computers, *Groundwater, *Surface water, Time series analysis, Network design, Mathematical studies.

A good user interface is an essential requirement for ground and surface water data systems. The major difference between the different data types is that surface water data has less variability but has larger volumes than groundwater data. Searching facilities and the ability to locate the data geographically are vital parts of any groundwater system. The efficient manipulation of large quantities of time series data is essential for a surface water system. These differences result in data systems with fundamentally different design objectives in the data handling, but similar objectives in the way the user operates the systems. Two software packages have been developed based on these principles. In developing both surface water and groundwater systems which are suitable for a wide range of applications sometimes compromises have to be made in the interest of getting a viable system for operation on personal computers. However, with the rapidly increasing storage capacity, memory and processing speeds of forthcoming generations of personal computers, the systems described will be able to expand to hold both larger data sets and offer more facilities including data analysis options. (See also W90-04274) (Hammond-PTT)
W90-04301

POLLUTION OF GROUNDWATER.
Princeton Univ., NJ. Water Resources Program.
For primary bibliographic entry see Field 5B.
W90-04353

RECHARGE-DISCHARGE AREA, PIEZOMETRIC SURFACE, AND WATER CHEMISTRY CHARACTERISTICS OF THE TERTIARY LIMESTONE AQUIFER SYSTEM IN SOUTH CAROLINA.
South Carolina Univ., Columbia. Dept. of Geology.
D. J. Colquhoun, R. L. Gardner, and K. B. Steele.
South Carolina Water Resources Research Institute, Clemson University, Clemson, SC. June 1986. Report No. 123.

Descriptors: *Geochemistry, *Limestone, *Geohydrology, *Water chemistry, *Aquifer characteristics, *Surface-groundwater relations, *Hydrologic data collections, *South Carolina, Aquifer systems, Aquitards.

Chronostratigraphy and hydrostratigraphy are outlined along three cross-sections--northeast of the Savannah River Plant from Barnwell to the Fall Line, and at right angles to that section through the McBean Type Section area and through Girard, Georgia. The Middendorf, Black Creek, and four subsystems of the Tertiary Sand Aquifer System are examined with respect to chronostratigraphic unconformities. The updip relationship of the Tertiary Sand Aquifer System to the downdip tertiary Limestone (Floridan) Aquifer System is examined. Three regional aquitards, the Cretaceous Clay Enrichment Zone, the Ellerton, and the Congaree Clay are placed with respect to the aquifers. The Tertiary Sand Aquifer Subsystem is subjected to computer mapping through modified surface analysis. Tectonic distortion of the Tertiary Sand Aquifer system is indicated. All known existing chemical groundwater analyses are assembled and subjected to computer analyses to calculate present unknown variables. Of 635 analyses only 228 are good enough to produce a less-than-10% change balance control. (Author's abstract)
W90-04489

LAND USE EFFECTS ON GROUND WATER QUALITY IN CARBONATE ROCK TERRAIN.
Arkansas Univ., Fayetteville. Dept. of Geology.
For primary bibliographic entry see Field 4C.
W90-04491

SUBSURFACE GEOLOGY OF THE ST. CROIX CARBONATE ROCK SYSTEM: PHASE II.
Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center.
I. P. Gill, and D. K. Hubbard.
Caribbean Research Institute, College of the Virgin Islands, St. Thomas, U.S.V.I., Technical Report No. 28, May 1987. 66p. 14 fig, 24 ref.

Descriptors: *Paleohydrology, *Subsurface mapping, *Carbonate rocks, *Geohydrology, *Virgin Islands (US), Geologic history, Stratigraphy, Dolomite, Limestone.

Test holes drilled into the central carbonate plain of St. Croix, VI, allow lithologic and biostratigraphic correlation in a north to south transect from Krausses Lagoon to Estate St. John and in a west to east transect from Estate Hesselberg to Estate Pearl. The drilling establishes the existence of a probable Pliocene reef and shallow-water facies trend that rims the western and southern coastlines of the central plain. The greatest thickness of Pliocene sediments occurs in a subsidiary graben block in the south coast industrial area. The Pliocene post-Kingshill carbonates are less extensive than the Miocene Kingshill Limestone, but are generally more permeable. Dolomitization in the Pliocene carbonates rims what was the coastline of Krausses Lagoon before industrial development modified the shoreline in the 1960s. The geographical distribution of the dolomite suggests a hydrologic correlation between Krausses Lagoon and the formation of dolomite. Structural mapping on the upper surface of the Miocene Jealousy Formation indicates marked upwarping under the carbonate highlands. The patterns suggest a basin opening to the south, but with a depocenter located under the present position of the carbonate highlands. Despite the marked color change, there are surprisingly few mineralogic or paleontological differences between the Jealousy Formation and the Kingshill Limestone, and the contact between the two formations does not imply significant paleobathymetric change. (Author's abstract)
W90-04496

GROUND WATER POLLUTION: GENERAL STUDIES. FEBRUARY 1988-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W90-04497

GROUND WATER POLLUTION: GENERAL STUDIES. DECEMBER 1984-JANUARY 1988 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-857080. Price codes: N01 in paper copy; N01 microfilm. Mar 89. 162p.

Descriptors: *Bibliographies, *Groundwater pollution, *Water pollution sources, *Path of pollutants, Literature review, Landfills, Mine drainage, Mathematical models.

This bibliography contains 319 citations concerning sources, contaminant transport, and monitoring of pollutants in aquifers. Topics include pollution characterization from landfills and mine drainage, descriptions of study programs undertaken by specific states, and superfund site studies of contaminated areas. The utilization of mathematical models is also discussed. Studies pertaining specifically to irrigation and pollution from fertilizers are excluded. (See also W90-04497) (Author's abstract)
W90-04502

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1984.
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04530

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1984.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04531

WATER RESOURCES DATA FOR ARIZONA, 1983.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-04532

WATER RESOURCES DATA--ARKANSAS, WATER YEAR 1984.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04533

WATER RESOURCE DATA--ARKANSAS, WATER YEAR 1985.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04534

WATER RESOURCES DATA FOR CALIFORNIA, 1983. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04535

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1983 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04536

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04537

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04538

WATER RESOURCES DATA FOR CALIFORNIA, 1984 VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04539

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04540

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04541

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04542

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04543

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04544

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04545

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1983.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04546

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1984.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04547

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1A: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04548

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1B: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL.
For primary bibliographic entry see Field 7C.
W90-04549

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04550

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04551

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 3B: SOUTHWEST FLORIDA - GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04552

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1983. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04553

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 1A: NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-04554

2G. Water In Soils

FURROW IRRIGATION INFILTRATION AND EVALUATION.
Soil Conservation Service, Greenwood, MS.
For primary bibliographic entry see Field 3F.
W90-03715

METHODOLOGY, RESULTS, AND SIGNIFICANCE OF AN UNSATURATED-ZONE TRACER TEST AT AN ARTIFICIAL-RECHARGE FACILITY, TUCSON, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03754

PHYSICALLY BASED NETWORK MODEL FOR TWO- AND THREE-PHASE SATURATION--CAPILLARY PRESSURE RELATIONSHIPS.
Massachusetts Inst. of Tech., Cambridge.
M. A. Celia, and L. A. Ferrand.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-236277/AS, price codes: A03 in paper copy, A01 in microfiche. Final Report, (1989). 15p, 5 fig, 23 ref. USGS Contract no. 14-08-0001-G1473.

Descriptors: *Model studies, *Simulation analysis, *Porous media, *Multiphase flow, *Saturation, *Capillarity, Networks, Fluid displacement, Two-phase models, Three-phase models.

Computational network models may be used to simulate multiphase fluid displacement in porous media. In these models, the governing physical processes are described at the pore scale. The pore space is modeled as a regular lattice of pores and throats, and the governing equation is the Young-Laplace equation of capillary displacement. Computation models can be constructed to simulate a typical laboratory experiment and used to obtain constitutive relationships such as the dependence of relative saturation on capillary pressure. Appropriate definitions of bulk properties allow saturation--capillary pressure (S-Pc) relations to be calculated from the network model results. These S-Pc curves exhibit all of the important features of measured curves, including entry pressures, hysteresis, and residual saturations. Results for two-phase models on both two-dimensional and three-dimensional lattices demonstrate the fundamental importance of dimensionality in multiphase problems: physically meaningful results can only be obtained in three dimensions, not in two dimensions. In addition, minimum size requirements for definitions of a 'representation elementary volume' (REV) can be determined for three-dimensional lattices. Computational experiments and comparison to actual laboratory measurements indicate significant sensitivity of the S-P relation to pore-size distribution. Extension to three-phase displacement problems can be accomplished by judicious modification and enhancement of the two-phase model. These two-phase and three-phase models provide an important tool for studying many fundamental aspects of multiphase capillary displacement in porous media, including influences of wettability, material heterogeneities, and scale. They can also guide the design of related physical experiments. (USGS)
W90-03890

SOIL PHASE PHOTODEGRADATION OF TOXIC ORGANICS AT CONTAMINATED DISPOSAL SITES FOR SOIL RENOVATION AND GROUNDWATER QUALITY PROTECTION.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5D.
W90-03893

MODELING SOLUTE TRANSFER FROM SOIL TO SURFACE RUNOFF: THE CONCEPT OF EFFECTIVE DEPTH OF TRANSFER.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 5B.
W90-03908

SOLUTION OF THE NONLINEAR BOUSSINESQ EQUATION FOR PHREATIC FLOW USING AN INTEGRAL BALANCE APPROACH.
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 7C.
W90-03909

BACTERIAL ABUNDANCE AND ACTIVITY IN HAZARDOUS WASTE-CONTAMINATED SOIL.
Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W90-03938

ORIGIN OF THE CHEMICAL COMPOSITION OF RUNOFF WATERS IN A TROPICAL RAIN ZONE: STUDY OF TWO SMALL FORESTED WATERSHEDS IN FRENCH GUYANA (ORIGINE DE LA COMPOSTION CHIMIQUE DES EAUX SUPERFICIELLES EN MILIEU TROPI-

CAL HUMIDE: EXEMPLE DE DEUX PETITS BASSINS VERSANTS SOUS FORET EN GUYANE FRANCAISE).
Office de la Recherche Scientifique et Technique Outre-Mer, Cayenne (French Guiana).
For primary bibliographic entry see Field 2K.
W90-03951

MODEL FOR THE RELATIONSHIP BETWEEN THE HYDRAULIC CONDUCTIVITY AND PRIMARY SEDIMENTARY STRUCTURES OF TILL.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03983

INFILTRATION INTO A FROZEN HEAVY CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
B. Thunholm, L. C. Lundin, and S. Lindell.
Nordic Hydrology NOHYBB, Vol. 20, No. 3, p 153-166, 1989. 9 fig, 1 tab, 30 ref.

Descriptors: *Infiltration rate, *Infiltration, *Snowmelt, *Seasonal distribution, *Frozen ground, Runoff, Arable land, Comparison studies, Thawing, Clays, Soil temperature.

The infiltration of snowmelt water on arable land influences both the water storage and the nutrient budget. The infiltration rate during thawing was assumed to depend on the ice content of the soil. Field measurements of soil temperature, water content, and infiltration rate were made and used to test a numerical model. Efforts were made to create different ice contents in three plots by adding different amounts of water before freezing as well as during winter. The total water content in spring was not influenced by the pre-freezing addition of water, but was slightly increased by water added during the winter. The simulated total water content was constant throughout the winter. The measured infiltration rates were high, at maximum 8 mm/min, and the differences between the plots were small, although lower infiltration rates were found in plots with higher amounts of added water. Simulated infiltration rates never exceeded 0.1 mm/min. The discrepancy probably was due to water flow in the partially unfrozen crack system, which the model could not simulate, and to the time lag in the simulated soil temperature during thawing. Low infiltration rates probably were caused by high ice content in the cracks, originating from the added water. It should be possible to predict the infiltration capacity during thawing using a simple model that considers the crack system, the water content before freezing and the number and intensity of warm spells during the winter. (Author's abstract)
W90-03984

RECLAMATION OF SALINE SOILS USING CALCIUM SULFATE RESIDUES FROM THE TITANIUM INDUSTRY.
Centre de Recherches de Colmar (France).
For primary bibliographic entry see Field 5G.
W90-04005

PRACTICAL SOIL MOISTURE PROFILE MODEL.
Virginia Military Inst., Lexington. Dept. of Civil Engineering.
J. R. Groves.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 875-880, August 1989. 5 fig, 3 tab, 11 ref.

Descriptors: *Hydrologic budget, *Soil water, *Model studies, *Moisture profiles, Rainfall, Evaporation, Soil columns, Computer models, Remote sensing.

A computationally simple, physically based model capable of generating reliable estimates of volumetric soil moisture content was developed. The model requires only rainfall, pan evaporation, and soil column description by texture group as inputs, and predicts soils moisture values within as many as three user-defined soil horizons. The principal algorithms of the current model were developed as components of the Remote Sensing Based Watershed Model. Moisture is added to the soil column as infiltration and is withdrawn both as evapotranspiration and as gravity drainage from the bottom of the column. Rainfall and evaporation data are input from an external data file. The two major elements of the soil moisture model are the infiltration and soil moisture redistribution components. Continuous simulation is accomplished by alternating calls to the two components for rainfall and dry periods. The model has a sound physical basis and has been shown to generate reliable estimates of soil moisture profiles. Data requirements are minimal and are of the nature that can be readily collected in the field. The microcomputer based model is intended for practical engineering and agricultural applications. (Author's abstract)
W90-04185

SOIL WATER CHARACTERISTICS OF TWO SOIL CATENAS IN ILLINOIS: IMPLICATIONS FOR IRRIGATION.
Michigan State Univ., East Lansing. Dept. of Geography.
For primary bibliographic entry see Field 3F.
W90-04206

CHEMICAL PROPERTIES OF SOILS AND STREAMS IN NATURAL AND DISTURBED FOREST ECOSYSTEMS IN THE OUACHITA MOUNTAINS.
Arkansas Univ. at Monticello. Dept. of Forest Resources.
For primary bibliographic entry see Field 2E.
W90-04494

2H. Lakes

WATER COLUMN PRODUCTION.
Alaska Univ., Fairbanks. Inst. of Marine Science.
R. T. Cooney, and K. O. Coyle.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 93-115, 4 fig, 4 tab, 51 ref.

Descriptors: *Arctic zone, *Valdez, *Productivity, *Zooplankton, *Ecological distribution, *Alaska, Fjords, Seasonal variation, Species diversity, Organic matter, Advection.

The production cycle in Port Valdez, Alaska, is typical for subarctic fjords. A spring diatom bloom in April and May is replaced by phytoflagellates in the summer months. The annual primary production ranges between 150 and 200 g C/sq m. There is no information on zooplankton production or seasonal variations in abundance. The community composition, a mixture of oceanic and neritic species, is similar to that reported for coastal Alaska. Drawing from other studies of this community in similar fjords and estimates of the amount of organic matter consumed annually, it is estimated that between 20 and 50 g C/sq m are produced annually by the zooplankton in Port Valdez. Stocks are probably augmented through advection of zooplankton into the fjord by subsurface compensatory flow from Prince William Sound and the Gulf of Alaska. (See also W90-03610) (Lantz-PTT)
W90-03615

SUBLETHAL EFFECTS OF PETROLEUM ON BIOTA.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
For primary bibliographic entry see Field 5C.
W90-03622

SYSTEMS APPROACH TO WATER QUALITY MANAGEMENT DURING DROUGHT PERIODS IN THE CUMBERLAND RIVER BASIN.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W90-03719

EVALUATION OF INSTREAM FLOW REQUIREMENTS OF FISHES IN THE OZARK AND OUACHITA NATIONAL FORESTS, ARKANSAS.
Forest Service, Hot Springs, AK.
D. J. Ebert, S. P. Filipek, and J. R. Dillard.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 113-120. 1 tab, 37 ref.

Descriptors: *Instream flow, *Arkansas, *Aquatic habitats, *Stream biota, *Aquatic environment, *Fish populations, *Streamflow, Ecosystems, Low flow, Seasonal variation, Flow velocity, Water depth, Performance evaluation, High flow, Ecological distribution.

Instream flow requirements have been defined as the quantity of water needed to maintain the existing and planned inplace uses of water in or along a stream channel or other water body and to maintain the natural character of the aquatic system and its dependent systems. Various methods of instream flow evaluation are reviewed. The 'Arkansas method', which utilizes topographic characteristics, soils, vegetation, and land use to characterize ecoregions, was chosen and tested for forest streams, for determination of low flow requirements for fish population in these forest streams, and for determination of habitat requirements for eleven species of fish representative of Ozark and Ouachita mountain streams. Results of this study showed that slender madtom (Noturus exilis), orangethroat darter (Etheostoma spectabile), orangebelly darter (E. radiosum), banded sculpin (Cottus carolinae), and central stoneroller (Campostoma anomalum) were captured most frequently in shallow riffle or raceway habitat. These species preferred depths ranging from 0-30 cm, velocities from 0-20 cm/sec, and gravel-rubble substrate. Populations of these species were somewhat lower during winter and spring (high flow units) sample periods when there was more wetted area present, faster velocities, and deeper waters. During the summer-fall low flow unit, fish density was higher, but wetted areas, velocity, and depth were much less. The Arkansas Method, based on mean monthly flow, provides adequate protection of fisheries but does not account for total flow of streams. (See also W90-03708) (Friedmann-PTT)
W90-03727

SUITABILITY CRITERIA FOR ASSESSMENT OF INSTREAM FLOW NEEDS OF FISH.
National Ecology Research Center, Fort Collins, Co.
J. H. Crance.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 130-135. 4 fig, 62 ref.

Descriptors: *Stream biota, *Fish populations, *Aquatic habitats, *Instream flow, *Research priorities, *Fish behavior, Channel morphology, Streamflow, Aquatic environment, Fish migration, Headwaters, Larval growth stage, Water temperature, Invertebrates, Water quality, Streambeds.

The need, development, and use of stream habitat suitability criteria, and of the use of these criteria for the assessment of instream flow needs are reviewed. A status report on the plan of the National Ecology Research Center (NERC) for the expansion of instream flow research in the Southeast is given, and the relevancy of the research to river corridor management is reviewed. The goal of the instream flow research supported by NERC in the Southeast is broad but does not cover all potentially important mechanisms affecting stream fish and invertebrates. Water quality, stream bed substrate patterns, channel morphology, fish migration patterns, and food supply may be affected adversely by various watershed and stream developments. Information about habitat use and requirements by larval fish in warmwater streams is inadequate. Coldwater and warmwater streams have been contrasted and it has been concluded that the distinction may be between headwater streams and large

main-stem streams. Almost all research on headwater streams has been done in coldwater streams, but the Southeast has many small, steep warmwater streams. Research on these systems would enhance current research and understanding of fish-habitat relations in different stream systems of the Southeast. Significant advances in assessing instream flow measurement have been made over the past several decades, but much more research is needed to advance the state of the art, especially for warmwater streams. It is hoped that NERC research will provide some of the criteria needed for the evaluation and protection of instream flows and will serve as a stimulus for more comprehensive and cooperative research in warmwater stream ecology in the Southeast. (See also W90-03708) (Friedmann-PTT)
W90-03729

INVESTIGATION OF A SHORELINE ENHANCEMENT TECHNIQUE FOR WETLANDS IMPACT MITIGATION.
Georgia State Univ., Atlanta. Dept. of Biology.
F. K. Parrish.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-143192. Price codes: A04 in paper copy, A01 in microfiche. Final Report, August 1988. 78p, 6 fig, 11 tab, 25 ref. Georgia Department of Transportation Project No. 8502.

Descriptors: *Wetlands, *Water pollution prevention, *Highway effects, Highways, Shore protection, Environmental protection, Benthic environment, Beavers, Fish, Ponds.

An attempt was made to mitigate the impact of highway construction on a wetland (beaver pond) margin by enhancing the shoreline of the roadfill. One hundred 20' long finger-like extensions 10' wide were constructed 10' apart along the roadfill. The extensions increased the pond-roadfill margin by a factor of 3. In addition, weeping willows and blackwillows were planted on the southeastern edge of the fingers. Despite the repeated destruction of the beaver dam by county surveyors, and two successive drought years, the procedure appeared successful. Transects were compared in 3 areas; the improved, with the fingers; an unimproved section of roadfill; and a 'control' across the pond from the roadfill. Sampling of the pond margin communities over a three period revealed up to 89% the number of benthic invertebrates in the improved area as in the control; only 44% of benthos in the unimproved as in the control. Trees occurred on the fingers at a rate 2.3 times greater and with higher species diversity in the improved compared to the unimproved. Fish utilized the improved area about 4 times as much as the unimproved. A modification of the USFWS HEP showed 9 times the Habitat Units in the improved over the unimproved per linear foot of road bed. Recommended modifications of the shoreline include making the fingers longer and wider, the sloughs wider and deeper, and erosion control and less slope to prevent excessive sedimentation. (Author's abstract)
W90-03756

RESERVOIR SHORELINE EROSION AND REVEGETATION WORKSHOPS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 4D.
W90-03760

WISCONSIN REGIONAL INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY (RILWAS): 1981-1983.
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
For primary bibliographic entry see Field 5B.
W90-03790

SITE DESCRIPTION.
Wisconsin Dept. of Natural Resources, Madison.
D. R. Knauer, J. G. Bockheim, A. J. Prey, and S. A. Brouwer.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 10-20, 7 fig, 1 tab, 9 ref.

Descriptors: *Limnology, Round Lake, East Eightmile Lake, Wisconsin, Paleohydrology, Geohydrology, Surface-groundwater relations, Lake morphology, Algae, Aquatic plants, Stratification.

Both Round and East Eightmile lakes are located in the northern Highland geographical province of Wisconsin. Glacial deposits cover the bedrock in the East Eightmile Lake watershed to depths of between 180-190 m. In the Round Lake watershed, these deposits cover bedrock to the depth of 32 m. The deposits are largely pitted outwash and were formed during the Wisconsin stage of the Pleistocene glaciation, which ended about 9500 years ago. Water percolates rapidly into the groundwater system, and the surface is a continuum of the groundwater table. There are no surface inflows or outflows from the lakes. Surface drainage area is nearly the same: 52 ha for Round Lake and 65 ha for East Eightmile Lake. The two study lakes have some similar characteristics, but in other important respects they are quite different. Both Round and East Eightmile lakes are clear water lakes of about the same surface area, with predominantly sand bottom near shore and little cultural development around the shoreline. Round Lake has greater depth and volume than East Eightmile Lake, but lower alkalinity. Round Lake stratifies in summer and winter while East Eightmile Lake does not. Also, Round Lake has few rooted aquatic plants but sometimes has a high algal population, whereas East Eightmile Lake has more macrophytes and generally lower algal densities. (See also W90-03790) (Lantz-PTT)
W90-03791

ATMOSPHERIC INPUT.
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 5B.
W90-03792

TERRESTRIAL COMPONENT.
Wisconsin Univ., Madison.
For primary bibliographic entry see Field 5B.
W90-03793

HYDROLOGIC COMPONENT.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-03794

LIMNOLOGICAL COMPONENT.
Wisconsin Dept. of Natural Resources, Madison.
P. J. Garrison.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 168-195, 11 fig, 6 tab, 23 ref.

Descriptors: *Acid rain, *Limnology, *Weathering, *Wisconsin, *Water chemistry, Bicarbonates, Calcium, East Eightmile Lake, Round Lake, Conductivity, Minerals, Calcium, Magnesium, Potassium, Sodium, Silicates, Chlorides, Hydrogen ion concentration, Seasonal variation, Surface-groundwater relations, Sulfates, Nitrates, Alkalinity, Lake sediments, Sulfur bacteria.

In Round and East Eightmile lakes bicarbonate is the dominant anion and calcium the dominant cation. East Eightmile Lake has a higher conductivity. More products of mineral weathering are entering East Eightmile Lake, presumably through the groundwater. In both lakes, Ca, Mg, K, Na, HCO3, and SiO2 are enriched relative to Cl. Hydrogen, NO3, NH4, and SO4 are diminished relative to chloride. Sulfate is probably depleted by bacterial sulfate reduction primarily in the epilimnetic sediments. Little permanent alkalinity was produced in the anoxic hypolimnion of Round Lake. The pH values fluctuate seasonally by three to four units in both lakes, as the result of photosynthetic uptake of CO2 and the relatively low buffering capacity of these lakes. (See also W90-03790) (Lantz-PTT)
W90-03795

CHEMICAL INPUT-OUTPUT BUDGETS.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-03796

MODELLING COMPONENT.
Tetra Tech, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5B.
W90-03797

DIATOMS OF BURRINJUCK RESERVOIR, NEW SOUTH WALES, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
J. Holland, and R. L. Clark.
CSIRO Divisional Report 89/1, June 1989. 79p, 2 fig, 39 ref, 2 append.

Descriptors: *Diatoms, *Limnology, *Land use, *Australia, Burrinjuck Reservoir, New South Wales, Reservoir sediments, Data collections, Classification, Microorganisms.

As part of a project investigating the effects of land use change in the catchment of Burrinjuck Reservoir in south-eastern New South Wales, Australia, diatoms deposited in the reservoir sediments between 1925 and 1984 were extracted, identified and counted. Some living diatoms were also collected and identified. The report presents photographs of the identified diatoms, a summary of their classification and the methods used. It is hoped that this research will provide a basis for similar studies of the history of other Australian water storages and lakes. (Author's abstract)
W90-03804

LIVING WITH THE LAKES: CHALLENGES AND OPPORTUNITIES.
International Joint Commission-United States and Canada, Windsor (Ontario).
For primary bibliographic entry see Field 6A.
W90-03816

EFFECTS OF HIGHWAY RUNOFF ON WATER QUALITY OF TWO WETLANDS IN CENTRAL FLORIDA.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 5G.
W90-03874

GROUNDWATER'S DYANAMIC ROLE IN REGULATING ACIDITY AND CHEMISTRY IN A PRECIPITATION-DOMINATED LAKE.
Wright State Univ., Dayton, OH. Dept. of Geological Science.
G. J. Kenoyer, and M. P. Anderson.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 287-306, August 1989. 8 fig, 2 tab, 51 ref. NSF Contract DEB8012313.

Descriptors: *Water chemistry, *Acidic water, *Acid rain effects, *Groundwater movement, *Surface-groundwater relations, *Lakes, Hydrological regime, Heavy metals, Dissolved solids, Seasonal variation, Aquifers, Hydrogen ion concentration, Alkalinity.

The role of groundwater in regulating the hydrologic and chemical regime of an 'acid-susceptible' lake situated in a sandy silicate aquifer in northern Wisconsin was determined by direct groundwater measurements using a network of 68 piezometers. Groundwater inputs were compared with precipitaton and dryfall components of the hydrologic and chemical budgets for the lake. Groundwater contributed only 10% of the water to Crystal Lake in 1982 but was the major source of alkalinity, calcium, magnesium, sodium, potassium, silicon, and chloride. Precipitation contributed 90% of the water and was the major source of hydrogen and

sulfate ions. Continuing analyses suggest that groundwater consistently supplies the bulk of the inorganic constituents to the lake on an annual basis. The flux of groundwater and dissolved solids to the lake is highly seasonal, with large pulses of groundwater inflow occurring after spring snowmelt and in the fall. For certain nonconservative elements such as silicon, the periodic influx of chemically concentrated groundwater can trigger significant changes in the chemical and biological balance in the lake. Despite the fact that the aquifer contains no carbonate minerals and the areas experiences acid precipitation (pH = 4.6), the alkalinity of the small amount of groundwater entering Crystal Lake is more than enough to neutralize all of the acidity contributed by precipitation. In-lake sulfate reduction may generate an equal amount of alkalinity. This buffering of pH helps to regulate aluminum concentrations at low levels, thus minimizing potential aluminum toxicity in the lake. Most lakes in the region probably receive even larger amounts of alkalinity-rich groundwater than Crystal Lake, because most lie further downgradient in the regional flow system. This may help to explain why most lakes in this 'acid-susceptible' area are no more acidic today than they were 50 years ago. (Author's abstract)
W90-03907

HYDROCHEMICAL BUDGETS FOR THE LOCH DEE EXPERIMENTAL CATCHMENTS, SOUTHWEST SCOTLAND (1981-1985).
Saint Andrews Univ. (Scotland). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2K.
W90-03911

DISCHARGE OF BACTERIA RESISTANT TO HEAVY METALS FROM SEWAGE EFFLUENT INTO FRESHWATER.
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 5E.
W90-03964

FOOD-WEB MANIPULATION AS A TOOL IN WATER-QUALITY MANAGEMENT.
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
For primary bibliographic entry see Field 5G.
W90-03971

EFFECT OF ORGANIC CARBON SUPPLY IN WATER ON THE ANTIBIOTIC RESISTANCE OF BACTERIA.
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 5F.
W90-04011

SPECIFICITY OF CELLULAR DNA-BINDING SITES OF MICROBIAL POPULATIONS IN A FLORIDA RESERVOIR.
University of South Florida, St. Petersburg. Dept. of Marine Science.
J. H. Paul, and S. L. Pichard.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2798-2801, November 1989. 3 fig, 1 tab, 21 ref. NSF Grant BSR 8605170.

Descriptors: *Limnology, *Bacterial physiology, *DNA, *Reservoirs, *Florida, *Absorption, *Aquatic bacteria, Phosphorus, Nucleic acids, Proteins.

The substrate specificity of the DNA-binding mechanisms of bacteria in a Florida reservoir was investigated in short-term and long-term uptake studies with radiolabeled DNA and unlabeled competitors. Thymine oligonucleotides ranging in size from 2 base pairs to 19 to 24 base pairs inhibited DNA binding in 20-min incubations by 43 to 77%. Deoxynucleoside monophosphates, thymidine, and thymine had little effect on short-term DNA binding, although several of these compounds inhibited the uptake of the radiolabel from DNA in 4-hr incubations. Inorganic phosphate and glucose-1-phosphate inhibited neither short-term nor long-term binding of 3H-DNA or 32P-DNA, indicating that DNA was not utilized as a phosphorus source in this reservoir. RNA inhibited both short-term and long-term radiolabeled DNA uptake as effectively as unlabeled DNA. Collectively these results indicate that aquatic bacteria possess a generalized nucleic acid uptake/binding mechanism specific for compounds containing phosphodiester bonds and capable of recognizing oligonucleotides as short as dinucleotides. This binding site is distinct from nucleoside-, nucleotide-, phosphomonoester-, and inorganic phosphate-binding sites. Such a nucleic acid-binding mechanism may have evolved for the utilization of extracellular DNA (and perhaps RNA), which is abundant in many marine and freshwater environments. (Author's abstract)
W90-04029

EFFICACY OF PHOSPHOLIPID ANALYSIS IN DETERMINING MICROBIAL BIOMASS IN SEDIMENTS.
Maine Univ., Walpole. Ira C. Darling Center for Research, Teaching and Service.
For primary bibliographic entry see Field 7B.
W90-04034

SORPTION OF METALS TO BACILLUS SUBTILIS WALLS FROM DILUTE SOLUTIONS AND SIMULATED HAMILTON HARBOUR (LAKE ONTARIO) WATER.
Guelph Univ. (Ontario). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-04040

ACID-SENSITIVE WATERS OF THE ENGLISH LAKE DISTRICT: A STEADY-STATE MODEL OF STREAMWATER CHEMISTRY IN THE UPPER DUDDON CATCHMENT.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 5B.
W90-04042

HYDROGEN PEROXIDE CONCENTRATION IN A NORTHERN LAKE: PHOTOCHEMICAL FORMATION AND DIEL VARIABILITY.
Florida International Univ., Miami. Drinking Water Research Center.
For primary bibliographic entry see Field 5B.
W90-04052

SEDIMENT BIOGEOCHEMISTRY OF IRON AND SULFUR IN AN ACIDIC LAKE.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
J. R. White, C. P. Gubala, B. Fry, J. Owen, and M. J. Mitchell.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 10, p 2547-2559, October 1989. 8 fig, 4 tab, 58 ref. NSF Grant BSR-86-15191.

Descriptors: *Acid rain, *Limnology, *Iron, *Sulfur, *Lake sediments, *Acid lakes, *Geochemistry, Organic carbon, Paleolimnology, Interstitial water, Sulfates, Big Moose Lake, Diagenesis.

The biogeochemical cycling of Fe and S in the sediments of acidic Big Moose Lake, Adirondack Park, New York was investigated. Sediment cores and porewater samples were collected along a depth transect from the hypolimnion (24 m water depth), metalimnion (17 m), and epilimnion (8,12 m). Four vertically distinguishable zones in the sediment environment were observed at each site: (1) NO3(-) disappearance near the sediment/water interface; (2) accumulation of solid-phase Fe in the top 5 cm; (3) coincident accumulation of chromium reducible sulfur (CRS), disappearance of SO4(--) and minima in C:S and delta S34 at or slightly below maxima in oxide-bound Fe; and (4) homogenous background concentrations in S and Fe below 30 and 10 cm, respectively. Iron and sulfur accumulations in the upper 10 cm occurred at the same depths in cores of different ages, indicating that diagenetic rather than depositional processes played a dominant role in determining near-surface Fe and S profiles. Although sediment accumulation rates varied along the transect, the four zones were located at similar depths in the sediment column at all sites. Diagenetic processes play a major role in the development of these features in Big Moose Lake. The extent of Fe enrichment was considerably greater in the metalimnetic and epilimnetic sediments. In contrast, concentrations of Fe were lower in hypolimnetic sediments, which appeared to be losing Fe to the water column. At all sites, increases in total S from a background concentration of 60-80 micromol/gm of dry mass occurred in sediments dated approximately 1850. More recent increases to 560 micromol S/gm occurred asynchronously in the cores, indicating an important role of sulfate reduction in adding S to sediments. However, organic sulfur accumulation accounted for 22-56% of the recent increase in sediment S. Concentrations of iron and organic carbon were high in lake sediments and probably do not limit S storage in this lake. (Author's abstract)
W90-04054

RARE EARTH ELEMENTS IN SAANICH INLET, BRITISH COLUMBIA, A SEASONALLY ANOXIC BASIN.
Cambridge Univ. (England). Dept. of Earth Sciences.
C. R. German, and H. Elderfield.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 10, p 2561-2571, October 1989. 13 fig, 4 tab, 34 ref. NERC Studentship GT4/84/AAPS/60. NERC Grant GR3/6010.

Descriptors: *Metal scavening, *Trace elements, *Manganese, *Cerium, *Inlets, Dissolved oxygen, Fjords, Interstitial water, Sediments, Seasonal variation, Lakes, Saanich Inlet, Anoxic conditions.

Rare earth element (REE) and manganese distributions have been investigated in Saanich Inlet, British Columbia, a seasonally anoxic basin. Redox cycling of Ce and Mn takes place across an oxic/suboxic boundary approximately 20 m shallower than the O2/H2S interface; the remaining, strictly trivalent REE undergo scavenging above this oxic/suboxic boundary and regeneration from dissolving host phases below it. These processes result in pronounced removal of Ce from solution above the oxic/suboxic boundary due to oxidative precipitation along with preferential uptake of the lighter trivalent REE during scavenging. Below the oxic/suboxic boundary, regeneration of particulate-REE into solution leads to a less pronounced Ce-depletion and a less pronounced HREE-enrichment in the anoxic bottom waters. Dissolved REE concentrations in the sediment pore waters exhibit an approximately ten-fold increase across the seawater-sediment interface but then decrease with increasing depth, indicating removal from solution during later diagenesis. Calculated diffusive fluxes of the REE and Mn from the sediments into the overlying anoxic water column are insufficient to account for the accumulated trace metal enrichments observed in the water column. An annual redox cycle is proposed for Saanich Inlet in which flushing causes extensive oxidative precipitation and scavenging of trace elements from the water column each autumn. The same material is rapidly regenerated from the underlying near-surface sediments when the basin next turns anoxic. (Author's abstract)
W90-04055

GLUCOSE-MINERALIZATION POTENTIAL OF EPILITHIC BACTERIA IN DIVERSE UPLAND ACID HEADSTREAMS FOLLOWING A WINTER SPATE.
Hull Univ. (England). Dept. of Applied Biology.
R. Goulder.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 283-297, September 1989. 6 fig, 2 tab, 27 ref.

Descriptors: *Microbial degradation, *Acid streams, *Radiometry, *Glucose, *England, *Acid rain effects, Velocity, Hydrogen ion concentration, Aluminum, Conductivity, Stream discharge.

Large-volume radiorespirometry was used to determine maximum velocity (Vmax) for glucose mineralization by epilithic bacteria, from five acid headstreams in Colsterdale, England, while still attached to their natural stone surfaces. Measurements were made in winter and early spring, values of maximum velocity ranged from 0.5-41.2 ng/square cm/hour. Between-stream differences in maximum velocity and temporal changes following a spate were observed. In some streams, maximum velocity was positively correlated with pH and negatively with aluminum concentration, conductivity and discharge; multiple-regression analysis showed that, overall, 26% of variation in maximum velocity was explained by variation in physico-chemical variables. Therefore, Vmax was probably also controlled by other, unrecorded, environmental variables. The Vmax values measured (0.5-41.2 ng/sq cm/h) were higher than values obtained previously for epilithic bacteria in a similar acid stream in winter but using suspensions of dislodged bacteria. Thus it is suggested that the disruption caused by dislodgement may reduce metabolism of epilithic bacteria, although this is contrary to some other observations in the literature. (Author's abstract)
W90-04073

DISTRIBUTION OF AQUATIC BRYOPHYTES IN RELATION TO WATER CHEMISTRY OF THE ACID RIVER AKAGAWA, JAPAN.
National Inst. for Environmental Studies, Tsukuba (Japan).
K. Satake, M. Nishikawa, and K. Shibata.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 299-311, September 1989. 3 fig, 3 tab, 26 ref.

Descriptors: *Acid streams, *Aquatic plants, *Hydrogen ion concentration, *Aluminum, *Japan, *Mosses, Jungermannia, Scapania, Rhynchostegium, Sphagnum, Sodium, Magnesium, Potassium, Phosphorus, Calcium, Manganese, Iron, Water chemistry.

The distribution of aquatic bryophytes, elemental composition of their shoots (Na, Mg, Al, P, K, Ca, Mn, Fe) and water chemistry were studied in the system of the River Akagawa, Japan. The acid water of the river presents a typical acid environment for aquatic macrophytes, that may be a typical example of the law of tolerance controlled by excess hydrogen ion. The species of bryophytes studied were Jungermannia vulcanicola Steph., Scapania undulata (L.) Dum., Rhynchostegium riparioides (Hedw.) Card. and Sphagnum sp. Massive colonies of J. vulcanicola and S. undulata occurred in the pH range from 4.0 to 4.6. The colonies were covered by a precipitate of iron hydroxide, that ranged from 5 to 13% on a dry weight basis, and shoots contained K levels as high as 5%. The down stream portion of the River Akagawa showed a drastic change in water chemistry brought about by inflow of neutral water from a tributary that resulted in the deposition of aluminum compounds. J. vulcanicola in the acid water and R. riparioides in the neutral water disappeared after confluence. S. undulata was only the bryophyte remaining in the water under the precipitate of aluminum compounds, that exceeded 10% (Al) on a dry weight basis. (Mertz-PTT)
W90-04074

COMPARISON OF SOME LIMNOLOGICAL VARIABLES IN THE WATERS BETWEEN THE UPPER AND LOWER LITTORAL AREAS WITHIN AN EGERIA STAND.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
M. Nakanishi, C. Saraceni, and A. Kurata.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 313-331, September 1989. 11 fig, 2 tab, 26 ref.

Descriptors: *Japan, *Limnology, *Aquatic plants, *Lakes, *Phytoplankton, *Aquatic productivity, Seasonal variation, Nitrogen, Phosphorus, Hydrocharitaceae, Vitamin B.

An exotic submerged plant, Egeria densa (Hydrocharitaceae), rapidly propagated and was distributed widely in the 1970s in the south basin of Lake Biwa in Japan. Selected limnological variables were investigated in the waters from the upper to the lower littoral regions within the Egeria stand. High light attenuation in the water was observed in July and August in the upper littoral area due to the development of dense Egeria stand. During the growing and senescing periods (summer and autumn) of the Egeria community, concentrations of dissolved inorganic nitrogen, phosphorus and B-group vitamins were higher in the upper littoral than in the lower littoral. A decline in the chlorophyll-a concentration of phytoplankton toward the upper littoral was observed in May and June. Summer (July and August) decreases of phytoplankton productivity in the upper littoral were correlated with the extremely low photosynthetic activity of phytoplankton in the deep layer of Egeria stand and high light attenuation in the waters. (Author's abstract)
W90-04075

DIEL VARIATIONS IN A SHALLOW TROPICAL BRAZILIAN LAKE: I. THE INFLUENCE OF TEMPERATURE VARIATION ON THE DISTRIBUTION OF DISSOLVED OXYGEN AND NUTRIENTS.
Universidade Federal de Minas Gerais, Belo Horizonte (Brazil). Inst. de Ciencias Biologicas.
R. A. R. Barbosa, and J. G. Tundisi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 333-349, September 1989. 12 fig, 1 tab, 28 ref.

Descriptors: *Limnology, *Lakes, *Dissolved oxygen, *Thermal stratification, *Brazil, *Diurnal variation, Cycling nutrients, Hydrogen ion concentration, Conductivity, Water temperature.

Diel variations of wind speed and vertical profiles of water temperature, dissolved oxygen, pH, electrical conductivity and the major inorganic nutrients were measured on three occasions at a central station of Lake Carioca, Eastern Brazil. These corresponded to the beginning of stratification (September 1979), the maximum of stratification (February 1980), and complete mixing (July 1980). Distinct patterns of diel water temperature were identified and except for September, when periods of stratification and mixing of the whole water column were observed over 24 hours, temperature changes were mainly restricted to the epilimnion. Diel temperature cycles constitute a continuous possibility for discontinuous movement in the water mass, acting as an enrichment source for the euphotic zone and capable of increasing photosynthetic rates. The enrichment role depends on the extent of the diel variation within the water column as those restricted to the upper layers could not affect markedly the nutrient cycles and the distribution of the organisms. Considering the morphometric characteristics of Lake Carioca, mainly the absence of permanent inlets and outlets, and the well-defined temperature variations recorded for each studied period, the recorded diel changes are suggested to be primarily temperature-dependent. An induced alternation of stratification and mixing provides basic constraints for the ultimate physicochemical and biological processes. (Author's abstract)
W90-04076

OPTICAL PROPERTIES AND PHYTOPLANKTON OF LENTIC FRESHWATERS FROM NORTH-EASTERN NEW SOUTH WALES, AUSTRALIA.
University of New England, Armidale (Australia). Dept. of Botany.
L. C. Bowling.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 351-373, September 1989. 7 fig, 5 tab, 49 ref.

Descriptors: *Lakes, *Australia, *Light penetration, *Limnology, *Optical properties, Chlorophyta, Euglenoids, Dinoflagellates, Diatoms, Cyanophyta, Chrysophyta.

A survey of the optical properties and underwater light climates of lentic freshwaters in north-eastern New South Wales found most frequently were only moderately attenuating. Dissolved humic substances (gilvin) contributed extensively to the extinction of Photosynthetically Available Radiation within them, although suspended particulate matter (tripton) was also a significant attenuator, and phytoplankton had a role in the more eutrophic lakes and reservoirs. The spectral distributions of Photosynthetically Available Radiation at depth depended on the concentrations of these attenuating components. Wavelengths between 580 and 660 nm were transmitted best in the clearer study sites, but the more humic or turbid waters had narrow transmission windows centered between 680 and 700 nm. A diversity of phytoplankton, especially from the Chlorophyceae were present, although euglenoids, dinoflagellates, diatoms, cyanobacteria, and chrysophytes were also common. (Author's abstract)
W90-04077

AMELIORATION OF STORM-WATER QUALITY BY A FRESHWATER ESTUARY.
Ohio Dept. of Natural Resources, Huron, OH.
D. M. Klarer, and D. F. Millie.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 3, p 375-389, September 1989. 38 ref.

Descriptors: *Path of pollutants, *Nonpoint pollution sources, *Fate of pollutants, *Storm runoff, *Streamflow, *Lake Erie, Estuaries, Chemical properties, Sedimentation, Statistical analysis, Correlation analysis.

The role of Old Woman Creek Estuary, Lake Erie, in ameliorating the quality of storm-water flow was investigated. Water samples were collected at selected intervals immediately following two spring storms and an autumn storm. Using changes in turbidity as estimates of storm-water flow rates, chemical parameters followed three distinct patterns. Significant, negative correlations of calcium and magnesium concentrations and total alkalinity with turbidity indicated that these parameters were diluted by storm-water runoff. Significant, positive correlations of orthophosphate, iron, copper , zinc, potassium, and ammonia concentrations with turbidity indicated that these parameters were associated with sediment input and surface runoff. Silica, nitrate, and nitrite concentrations increased following storm events but much later than the turbidity peak, indicating that these parameters were associated with storm interflow. Outflow/inflow ratios of chemical concentrations, used as estimates of the estuary's relative effectiveness to modify waters passing through it, indicated that 12 to 60% of the metals and 35 to 80% of the biologically-important nutrients were retained within the estuary. Amelioration of storm-water quality was attributed to sedimentation, biological uptake, and geochemical processes. Old Woman Creek Estuary acted as a chemical processor and filter of storm-water flow and, therefore, demonstrates functional similarity to brackish-water estuaries. (Author's abstract)
W90-04078

LAKE ACIDIFICATION IN NORWAY: PRESENT AND PREDICTED FISH STATUS.
Norsk Inst. for Vannforskning, Oslo.
A. Henriksen, L. Lien, B. O. Rosseland, T. Traaen, and I. S. Sevaldrud.
AMBIO AMBOCX, Vol. 18, No. 6, p 314-321, 1989. 7 fig, 2 tab, 26 ref.

Descriptors: *Acid rain, *Water pollution effects, *Lakes, *Norway, *Acidic water, Chemical properties, Fish populations, Sulfates, Nitrates, Hydrogen ion concentration, Aluminum, Surveys.

The Thousand Lake Survey was conducted in Norway in the autumn of 1986 to determine both the chemical and the fish status of lakes in areas sensitive to acidic deposition. The survey was also designed to detect possible changes in water quality and fish status as a follow-up to the extensive regional surveys that were conducted in 1974-1975. Lakes and watersheds in widespread areas of southern Norway are affected by acidic precipitation. The greatest loss of fish populations is to be found in southernmost Norway. The number of barren lakes in southernmost and southwestern

Norway has doubled since 1971-1975. The chemical changes in these lakes are characterized by a decrease in calcium and sulfate and an increase in aluminum and nitrate concentrations. There has been little change in pH levels. The total land area affected by acidification has increased from 33,000 square km in 1974-1979 to 36,000 square km in 1986. In 1986, over 18,000 square km were almost totally damaged compared to 13,000 square km in 1974-1979. The greatest increase was registered in eastern Norway. At present, 52% of the lakes surveyed are endangered. An empirical model predicts that a 30% reduction in loadings of sulfur compounds would lead to the recovery of 28% of these. A further reduction of 50% would ensure viable conditions for fish in 40% of these lakes. These prognoses assume that of nitrate and humic compounds in these lakes remains constant. A further increase in nitrate concentrations might counteract effects of reduced sulfur deposition. (Author's abstract)
W90-04080

DEPENDENCE OF THE RESPIRATION RATE UPON OXYGEN CONCENTRATION IN WATER FOR SOME RHEOPHILOUS MAYFLY LARVAE (EPHEMEROPTERA).
Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
S. M. Golubkov, and T. M. Tiunova.
Aquatic Insects AQINDQ, Vol. 11, No. 3, p 147-151, 1989. 1 fig, 1 tab, 10 ref.

Descriptors: *Aquatic insects, *Mayflies, *Respiration, *Oxygen requirements, *USSR, Drunella, Cincticostella, Ecdyonurus, Siphlonrus, Ameletus.

The respiration rate of five species of mayfly larvae from the Soviet Far East (Drunella acrulea Allen, Cincticostella levanidovae Tshernova, Ecdyonurus dracon Kluge, Siphlonrus lacustris Eaton, Ameletus cedrensis Sinitshenkova) was measured in a closed respirometer and plotted against oxygen concentration. Most of the mayfly larvae studied proved to tolerate rather low oxygen concentrations in the water. They are able to maintain a constant respiration rate over a relatively wide range of oxygen concentrations. In the Kedrovaya River, these larvae inhabit biotopes with low streamflow, e.g., below stones in marginal river areas. Ameletus cedrensis is the only species studied where respiration rate drops over the entire range of oxygen concentrations studied. Apparently, this species cannot maintain a constant respiration rate as oxygen concentration declines because in connection with adaptations to rapid swimming, its gill apparatus has been reduced in size and efficiency. Evidently, this species should then be more oxyphilic than the others. (Author's abstract)
W90-04084

FACTORS AFFECTING ESTUARINE MEIOBENTHIC ASSEMBLAGE STRUCTURE: A MULTIFACTORIAL MICROCOSM EXPERIMENT.
Marine Biological Association of the United Kingdom, Plymouth (England).
M. C. Austen.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 130, No. 2, p 167-187, September 21, 1989. 7 fig, 3 tab, 71 ref.

Descriptors: *Macroinvertebrates, *Nematodes, *Copepods, *Salinity, *Estuarine environment, Statistical analysis, Species diversity, Nutrient requirements.

A multifactorial microcosm experiment incorporating one artificial and three natural estuarine meiofauna assemblages, three salinity levels and two feeding regimes was maintained for 48 weeks. Main factor and interaction effects on meiofaunal assemblage structure were assessed at the end of the experiment using multivariate (multidimensional scaling ordination) and univariate (factorial ANOVA) statistical techniques. Nematodes and harpacticoid copepods exhibited different responses to the treatments. Both multivariate and univariate methods revealed the same main factor effects on assemblage structure of each taxon but not the same interaction effects. Salinity strongly affected both taxa. The feeding regime (light and dark treatments to promote differential growth of diatoms and bacteria) affected copepod, but not nematode, assemblage structure. Interaction effects of feeding regime and salinity were observed for both taxa. For nematodes, initial assemblage structure affected final assemblage structure at higher salinities only and it did not affect copepod assemblages at all. Copepods appear to be less flexible in their nutritional requirements than nematodes and this is reflected by a tendency for copepod species assemblages in microcosms to become highly dominated. Among the nematodes, opportunistic nonselective deposit feeders and omnivores were dominant at the lowest salinity, while selective feeders and epigrowth feeders were predominant at higher salinities. In the absence of severe osmotic and physical disturbance stress, there appear to be surprisingly deterministic mechanisms involved in the maintenance and development of nematode assemblage structure. (Author's abstract)
W90-04097

BIVALVE SUSPENSION-FEEDING DYNAMICS AND BENTHIC-PELAGIC COUPLING IN AN EUTROPHICATED MARINE BAY.
Goeteborg Univ. (Sweden). Dept. of Zoology.
L. O. Loo, and R. Rosenberg.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 130, No. 3, p 253-276, October 12, 1989. 8 fig, 11 tab, 50 ref.

Descriptors: *Benthic fauna, *Eutrophication, *Mollusks, *Feeding rates, *Aquatic productivity, *Bays, *Sweden, Nitrogen compounds, Seasonal variation.

The open exposed Laholm Bay in the Kattagat (Sweden) is eutrophicated through riverine input, mainly by nitrogen. The benthic macrofauna down to 10 m depth (60 square km) is dominated by the suspension-feeding bivalves Cardium edule and Mya arenaria. To estimate the seasonal and annual consumption of seston by the suspension-feeders in Laholm Bay, three sets of observations were carried out. (1) The abundance and biomass of the macrofauna in this depth interval were assessed along eight transects. (2) The secondary production of the two bivalves was estimated over a 10-month period in two sampling squares. (3) The filtration rate of C. edule was determined in natural seawater in laboratory experiments during different seasons. The bivalves can in theory filter all of the water volume down to 10 m in 3 days and, thus, make a significant impact on the phytoplankton concentration. In the study, however, they filtered only approximately half of their potential feeding capacity, perhaps because food availability was low due to low turnover close to the bottom or due to physical disturbance. The majority of the phytoplankton is exported from the bay. Bivalve abundance, biomass, production and growth rate were moderate and generally lower than in adjacent areas to the north. In autumn, the bivalves consumed more than 90% of the seston in comparison with net-zooplankton consumption. An energy-flow diagram for the bivalves is presented including estimates of bivalve nitrogen excretion and biodeposition. (Author's abstract)
W90-04098

MICROZOOPLANKTON GRAZING ON PHYTOPLANKTON IN THE RHODE RIVER, MARYLAND: NONLINEAR FEEDING KINETICS.
Smithsonian Environmental Research Center, Edgewater, MD.
C. L. Gallegos.
Marine Ecology Progress Series MESEDT, Vol. 57, No. 1, p 23-33, September 15, 1989. 6 fig, 4 tab, 26 ref.

Descriptors: *Feeding rates, *Phytoplankton, *Zooplankton, Plankton, Food chains, Chlorophyll, Rhode River, Maryland, Growth rates.

The dilution technique estimates microzooplankton grazing on phytoplankton by reducing encounter rates between the microzooplankton predators and their phytoplankton prey. The technique was extended to the case in which grazing is a nonlinear function of phytoplankton concentration. By allowing microzooplankton clearance rates to vary between, but not within, dilution fractions, and assuming microzooplankton density remains constant, it was shown that the grazing impact on apparent phytoplankton growth rate bears a simple relationship to the functional response of the microzooplankton. Experiments in the Rhode River, Maryland demonstrated saturated feeding kinetics. Half-saturation chlorophyll concentrations occurred within a relatively small fraction (0.1 to 0.2) of initial concentrations, despite a 4-fold range in the latter, suggesting tight coupling between microzooplankton communities and their phytoplankton prey. Simulations with time-dependent equations coupling phytoplankton and microzooplankton growth laws indicated that inferences about the shape of the microzooplankton functional response from measurements of phytoplankton apparent growth rate are insensitive to change in microzooplankton density and to changes in clearance rates along the functional response. However, estimates of specific grazing coefficient are very sensitive to these changes. Equations were solved for the case when the specific ingestion rate of the microzooplankton is food-saturated. The solution allows for proper estimation of grazing coefficient in eutrophic systems whenever microzooplankton growth rate is observed. (Author's abstract)
W90-04113

PHOSPHATE ADSORPTION BY DIFFERENT SEDIMENT FRACTIONS IN LAKE BALATON AND ITS PROTECTING RESERVOIRS.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
V. Istvanovics, S. Herodek, and F. Szilagyi.
Water Research WATRAG, Vol. 23, No. 11, p 1357-1366, November 1989. 4 fig, 10 tab, 39 ref.

Descriptors: *Eutrophication, *Path of pollutants, *Hungary, *Lake sediments, *Reservoirs, *Phosphates, Langmuir isotherm, Adsorption, Saturation, Calcite, Primary productivity, Lake Balaton, Sediment chemistry.

Adsorption of phosphate by sediments could be described by the Langmuir isotherm. The adsorption capacity of the sediments increased with their NaOH-extractable iron content, and the energy of adsorption was proportional to their calcite content. Increasing phosphate saturation of the sediments could be demonstrated near the inlet of the Zala River into the Kis-Balaton reservoir, as a result of high external loading. Phosphate saturation of the sediments remained similar in the hypertrophic and mesotrophic basins of Lake Balaton. This was explained by the continuous renewal of calcite, the main phosphate sorbent in this calcareous lake. A comparison of the interstitial soluble reactive phosphorus concentration and the adsorption/desorption concentration limit, derived from the Langmuir isotherm, indicated that sorption is of major importance in regulation of the interstitial phosphate concentration. In Lake Balaton desorption occurs whenever the sediments are resuspended; adsorption takes place only in the sediments. In the two reservoirs, adsorption and biotic uptake are equally important in the removal of phosphate from the water, depending on the actual loading and primary production. (Author's abstract)
W90-04142

TESTING FOR TREND IN LAKE AND GROUND WATER QUALITY TIME SERIES.
Colorado State Univ., Fort Collins. Dept. of Statistics.
For primary bibliographic entry see Field 5A.
W90-04167

ESTIMATION OF RECHARGE FROM A RESERVOIR USING TWO WATER BUDGET MODELS.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-04168

ESTIMATING A CARBON/CHLOROPHYLL RATIO IN NANNOPLANKTON (CRETEIL LAKE, S-E PARIS, FRANCE).
Ecole Normale Superieure, Paris (France). Lab. d'Ecologie.
J. Garnier, P. Blanc, and D. Benest.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 751-754, August 1989. 1 fig, 2 tab, 27 ref.

Descriptors: *Phytoplankton, *Lakes, *France, *Chlorophyll, Biomass, Carbon, Zooplankton, Growth, Statistical analysis.

The phytoplankton biomass of the Creteil Lake was characterized through 47 paired measurements of particulate organic carbon and chlorophyll. When determining the transfers of organic carbon in the lake, the need to convert the phytoplankton biomass into carbon units led to the estimation of a carbon to chlorophyll ratio using regression analyses. An average C:Chl ratio of 80 was found for Creteil Lake. C:Chl has been found to be highly variable but the value commonly used is C:Chl = 40. In Creteil Lake, the high C:Chl value is due to the nannoplankton that dominate the lake. One factor that affects this ratio is zooplankton grazing that results in a loss of small phytoplankton species that are frequently dominant. The comparison of the turnover rate of phytoplankton carbon with the filtration rate of zooplankton is indicative of the dynamics of phytoplankton growth and removal. However, no general conversion factor apparently exists for natural populations; thus, more studies may be necessary for a better knowledge of the carbon budget in lakes. (Author's abstract)
W90-04171

ASSESSMENT OF SEDIMENT PHOSPHORUS INACTIVATION, KEZAR LAKE, NEW HAMPSHIRE.
New Hampshire Dept. of Environmental Services, Concord.
For primary bibliographic entry see Field 5G.
W90-04182

FLUVIAL SEDIMENT STORAGE IN WETLANDS.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
For primary bibliographic entry see Field 2J.
W90-04184

DETECTING BIOTIC AND HYDROGEOCHEMICAL PROCESSES IN LARGE PEAT BASINS WITH LANDSAT TM IMAGERY.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 7B.
W90-04195

COMPARISON OF STREAMFLOW GENERATION MODELS FOR RESERVOIR CAPACITY-YIELD ANALYSIS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04201

EVALUATION OF INFLOW TO MIRROR LAKE, NEW HAMPSHIRE.
Geological Survey, Lakewood, CO.
T. C. Winter, J. S. Eaton, and G. E. Likens.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 991-1008, October 1989. 10 fig, 3 tab, 14 ref.

Descriptors: *Surface-groundwater relations, *Hydrologic budget, *New Hampshire, *Watersheds, *Runoff, Unit-runoff method, Hubbard Brook, Mirror Lake.

Measured stream discharge plus calculated ground water discharge (total measured runoff) were compared with runoff calculated by the unit-runoff method for the two largest watersheds of Mirror Lake for 1981-1983. Runoff calculated by the unit-runoff method, using Hubbard Brook watershed 3 as the index watershed, was greater than the total measured runoff into Mirror Lake during periods of high flow and slightly less than the total measured runoff into Mirror Lake during periods of low flow. Annual calculated unit runoff was 17 to 37 percent greater than total measured runoff. Differences in monthly runoff are far greater, ranging from 0 to greater than 100 percent. For high flows the calculated unit runoff is about 2 times greater than total measured runoff. For low flows the northwest basin of Mirror Lake has the greatest ground water contribution compared to the other two basins. In contrast, Hubbard Brook watershed 3 has the least ground water contribution. (Author's abstract)
W90-04203

ROCK ISLAND DAM SMOLT MONITORING, 1987.
Public Utility District No. 1 of Chelan County, Wenatchee, WA. Power Operations Dept.
For primary bibliographic entry see Field 8I.
W90-04220

ECOLOGY OF ATLANTIC WHITE CEDAR WETLANDS: A COMMUNITY PROFILE.
Marine Biological Lab., Woods Hole, MA.
A. D. Laderman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-103326. Price codes: A07 in paper copy, A01 in microfiche. Biological Report 85(7.21), July 1989. 114p, 40 fig, 14 tab, 146 ref, 4 append.

Descriptors: *Ecology, *Swamps, *Conifers, *Ecological effects, *White cedar, *Cedar, *Wetlands, *Ecosystems, *Land use, Logging, Wildlife management, Wildlife habitats, Peat bogs, Reforestation, Drainage, Cultivation, Land development.

Atlantic white cedar is geographically restricted to freshwater wetlands in a narrow band along the eastern coastal United States from Maine to Mississippi. The shallow, dark, generally acid peatland waters are low in nutrients and are buffered by complex organic acids. Distinctive biotic assemblages grow under conditions too extreme for the majority of temperate-dwelling organisms. In many regions, cedar wetlands are refugia for species that are rare, endangered, or threatened locally or nationally. After centuries of development the landscape has been so changed that much of the tree's original habitat is destroyed. Major impacts include improper logging, draining, and substrate alteration for agriculture, and commercial construction. Stands can vigorously regenerate despite multiple incursions. With appropriate protection and aggressive management where necessary, Atlantic white cedar can also be reintroduced to many former cedar sites. (Author's abstract)
W90-04255

1987 SAVANNAH RIVER CURSORY SURVEYS.
Academy of Natural Sciences of Philadelphia, PA. Div. of Environmental Research.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-000464. Price codes: A04 in paper copy, A01 in microfiche. Report No. 88-10F, July 18, 1988. 61p, 17 tab, 29 ref.

Descriptors: *Water quality trends, *Bioindicators, *Stream biota, *Ecosystems, *Savannah River, Seasonal variation, Fish, Algae, Species diversity, Aquatic plants, Water quality.

The 1987 cursory surveys of algae, insect and fish communities of the Savannah River in the vicinity of the Savannah River Plant (SRP) were a continuation of long-term biomonitoring studies conducted on the river since 1951. The 1987 algae and fish studies indicate no differences in water quality among stations, or in comparison with recent years, whereas the insect study found evidence of reduced water quality in 1987 at Station 1 above the SRP and an improvement in water quality over-all in this research of the river in recent years. During the March/April collections, daily river flows were higher and more unstable than river flows encountered during the July, September and December collecting periods, thus shallow water habitat areas were not as prevalent during the spring survey as was the case in the summer and late fall. Lower numbers of non-diatom algae and aquatic macrophyte species were found during the March/April survey throughout the study are than during the December survey, reflecting both the higher river flow in March/April and the expected increase in aquatic macrophyte development following the extended summer growth period. Temporal patterns of increasing diversity at all stations suggest that water quality conditions throughout this region of the Savannah River have improved. During the 1987 fish survey, 460 fish specimens representing 26 species were collected. The rotenone collections of 1987 indicate that the continued presence of diverse fish communities typical of the Savannah River at all stations. Yearly differences noted in the catch success of certain species seem to be related to differences in water level among surveys, although the abundance of several species appears to have declined throughout the study area in recent years. (Lantz-PTT)
W90-04268

GEOMORPHIC EVIDENCE OF FREQUENT AND EXTREME FLOODS.
Wisconsin Univ.-Madison. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-04322

EUTROPHICATION AND LAKE MANAGEMENT.
Maine Univ. at Orono. Land and Water Resources Center.
P. D. Uttormark.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 121-133, 2 tab, 13 ref.

Descriptors: *Lake restoration, *Model studies, *Urban hydrology, *Water pollution control, *National Lake Restoration Program, *Eutrophication, *Lake management, Input-output models, Classification, Lake classification, Phosphorus, Cycling nutrients.

The EPA National Lake Restoration Program aims to assist states in classifying public lakes according to their trophic conditions, setting priorities for restoration, and implementing the renewal process. The lake renewal techniques can be divided into three general groups: nutrient inflow reduction, disruption of internal nutrient cycles, and acceleration of nutrient outflow. The usefulness of two sets of input/output models (I/O) in estimating the trophic condition of lakes and in describing the changes caused by implementation of the three groups of lake restoration techniques are examined. Conclusions concerning these models can be summarized as follows: (1) the two sets of models are basically similar and use a steady-state concentration of phosphorus (P) in the lake as an indicator of the lake's trophic status. The models are restricted to phosphorus-limited lakes and assume completely mixed flow-through reactors, constant influx of P, losses in P occurring through the outlet and through internal losses (sedimentation), and that net internal loss is directly proportional to the amount of P in the lake; (2) because of their limitations and simplifications, the I/O models can be applied only to the evaluation of the first set of restoration strategies: those that reduce nutrient inflow. Considering that the second set of strategies, disruption of internal nutrient cycles, have been the most commonly used in EPA's program (48 of 59 projects, including dredging in 35 lakes), the I/O models cannot be said to be broadly applicable to the planning and evaluation of lake management strategies; and (3) input/output models can be used reliably to predict the general trophic state which occurs in lakes as a result of reductions in phosphorus input. Data from 23 lakes experiencing reduction of nutrient inputs were compiled and the models were evaluated by comparing predicted and reported trophic status before and after nutrient abatement. The 1976 Vollenweider model yielded 'accurate' results in 82% of the cases; two other models worked somewhat less well--an 'ac-

curacy' rate of 70%. (See also W90-04338)(Lantz-PTT)
W90-04352

PROTECTION OF LAKES AND WETLANDS.
Rutgers - The State Univ., New Brunswick, NJ. Water Resources Research Inst.
For primary bibliographic entry see Field 5G. W90-04356

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT: MUNICIPAL, INDUSTRIAL AND AGRICULTURAL.
For primary bibliographic entry see Field 5D. W90-04392

WETLANDS ECOSYSTEMS: NATURAL WATER PURIFIERS.
Tennessee Valley Authority, Knoxville. Waste Technology Program.
For primary bibliographic entry see Field 5D. W90-04394

HYDROLOGIC FACTORS IN WETLAND WATER TREATMENT.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
For primary bibliographic entry see Field 5D. W90-04395

PHYSICAL AND CHEMICAL CHARACTERISTICS OF FRESHWATER WETLAND SOILS.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
S. P. Faulkner, and C. J. Richardson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 41-72, 14 fig, 3 tab, 131 ref.

Descriptors: *Land disposal, *Wetlands, *Soil-water-plant relationships, *Soil chemistry, Flooding, Swamps, Riparian land, Cycling nutrients, Oxidation-reduction potential, Nutrient removal, Wastewater treatment, Biological wastewater treatment, Water pollution control, Nitrogen, Sulfates, Iron, Aluminum, Manganese, Hydrogen ion concentration, Anaerobic conditions, Saturated soils, Acid mine drainage.

Wetland soils are dominated by anaerobic conditions induced by soil saturation and flooding. Freshwater wetland soils can be distinguished generally from upland, non-wetland soils by two interrelated characteristics: (1) an abundance of water and (2) accumulation of organic matter. Excess water causes many physical and chemical changes in soils, and wetland hydrologic regimes can range from nearly continuous saturation (swamps) to infrequent, short-duration flooding (riparian systems). The most significant result of flooding is the isolation of the soil system from atmospheric oxygen, which leads to a change from aerobic and oxidizing to anaerobic and reducing conditions and processes. The chemical and physical parameters of wetland soils as they relate to the construction of wetlands for wastewater treatment are reviewed, including: general soil physical and chemical properties; wetland soil chemical processes (oxidation-reduction potential in response to flooding, Eh/pH relations); wetland ecosystem processes and removal/retention mechanisms; and nutrient pools, transformations, and cycles (N, P, S, and Fe and Mn in mine drainage). To enhance transformation and storage, understanding of biogeochemical cycling in natural wetlands needs to be improved. Examples of the specific actions needed include: (1) for N removal, enhancement of denitrification by alternating oxidizing and reducing conditions; (2) for P removal, maintaining contact with soils high in Ca or oxalate-extractable (amorphous) Fe and Al; (3) for sulfate removal, the maintenance of permanent reducing conditions to permit sulfate reduction and S incorporation into sediments; and (4) for Fe and Mn removal from acid mine drainage, data are insufficient to develop hard and fast guidelines. (See also W90-04392) (Rochester-PTT)
W90-04396

WETLAND VEGETATION.
Louisiana State Univ., Baton Rouge. Dept. of Botany.
For primary bibliographic entry see Field 5D. W90-04397

WETLANDS MICROBIOLOGY: FORM, FUNCTION, PROCESSES.
Istituto di Ricerca sulle Acque, Rome (Italy).
For primary bibliographic entry see Field 5D. W90-04398

WETLANDS: THE LIFEBLOOD OF WILDLIFE.
National Wildlife Federation, Washington, DC. Fisheries and Wildlife Div.
J. S. Feierabend.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 107-118, 12 ref.

Descriptors: *Wildlife habitats, *Aquatic habitats, *Wetlands, *Limnology, *Land disposal, *Wastewater treatment, Water pollution control, Macrophytes, Animals, Ecosystems.

Wetlands and their role as wildlife habitat is reviewed, and the potential role of constructed wetlands as wildlife habitat is discussed. Topics include: the importance of wetlands as wildlife habitat; types of wildlife found in wetlands (invertebrates, amphibians, fish, reptiles, birds, and mammals); threatened and endangered wildlife in wetlands; issues and research needs related to constructed (wastewater treatment) wetlands as wildlife habitat; and constructed wetlands to augment the nation's wetlands base. Wetlands constructed for wastewater treatment can yield benefits beyond simply discharging water that meets water quality standards. Among the benefits that could be achieved with appropriate choice of design elements are: contributing to groundwater recharge or moderation of storm surges, providing food and cover for wildlife, providing transition zones to uplands, and yielding recreational benefits. Research is needed to ensure that using constructed wetlands for wildlife does not create a short-or long-term hazard for the wildlife that uses the wetland. Another important issue is designing in appropriate fluctuations in conditions to properly replicate natural wetlands without losing the ability to properly treat wastewater. Constructed wetlands are never likely to make a significant contribution toward replacement of the nation's lost wetlands on an areal basis. However, they can be significant in increasing local wetlands and creating wetlands where none had existed previously. These activities benefit local wildlife populations by enhancing habitat richness in areas lacking wetlands. (See also W90-04392) (Rochester-PTT)
W90-04399

CONSTRUCTED FREE SURFACE WETLANDS TO TREAT AND RECEIVE WASTEWATER: PILOT PROJECT TO FULL SCALE.
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
For primary bibliographic entry see Field 5D. W90-04400

ISELIN MARSH POND MEADOW.
Indiana Univ. of Pennsylvania.
For primary bibliographic entry see Field 5D. W90-04401

INTEGRATED WASTEWATER TREATMENT USING ARTIFICIAL WETLANDS: A GRAVEL MARSH CASE STUDY.
San Diego State Univ., CA. Graduate School of Public Health.
For primary bibliographic entry see Field 5D. W90-04402

SEWAGE TREATMENT BY REED BED SYSTEMS: THE PRESENT SITUATION IN THE UNITED KINGDOM.
Water Research Centre, Stevenage (England).
For primary bibliographic entry see Field 5D. W90-04403

AQUATIC PLANT/MICROBIAL FILTERS FOR TREATING SEPTIC TANK EFFLUENT.
National Aeronautics and Space Administration, Bay Saint Louis, MS. John C. Stennis Space Center.
For primary bibliographic entry see Field 5D. W90-04404

CREATION AND MANAGEMENT OF WETLANDS USING MUNICIPAL WASTEWATER IN NORTHERN ARIZONA: A STATUS REPORT.
Apache-Sitgreaves National Forests, Lakeside, AZ.
For primary bibliographic entry see Field 5D. W90-04405

LAND TREATMENT OF MUNICIPAL WASTEWATER ON MISSISSIPPI SANDHILL CRANE NATIONAL WILDLIFE REFUGE FOR WETLANDS/CRANE HABITAT ENHANCEMENT: A STATUS REPORT.
Mississippi Sandhill Crane National Wildlife Refuge, Gautier.
For primary bibliographic entry see Field 5D. W90-04406

WASTE TREATMENT FOR CONFINED SWINE WITH AN INTEGRATED ARTIFICIAL WETLAND AND AQUACULTURE SYSTEM.
National Fertilizer Development Center, Muscle Shoals, AL.
For primary bibliographic entry see Field 5D. W90-04407

TREATMENT OF ACID DRAINAGE WITH A CONSTRUCTED WETLAND AT THE TENNESSEE VALLEY AUTHORITY 950 COAL MINE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D. W90-04408

CONSTRUCTED WETLANDS FOR TREATMENT OF ASH POND SEEPAGE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D. W90-04409

USE OF WETLANDS FOR TREATMENT OF ENVIRONMENTAL PROBLEMS IN MINING: NON-COAL-MINING APPLICATIONS.
Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.
For primary bibliographic entry see Field 5D. W90-04410

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT AT AMOCO OIL COMPANY'S MANDAN, NORTH DAKOTA REFINERY.
Amoco Oil Refinery, Mandan, ND.
For primary bibliographic entry see Field 5D. W90-04411

UTILIZATION OF ARTIFICIAL MARSHES FOR TREATMENT OF PULP MILL EFFLUENTS.
Weyerhaeuser Co., Tacoma, WA. Technology Center.
For primary bibliographic entry see Field 5D. W90-04412

USE OF ARTIFICIAL WETLANDS FOR TREATMENT OF MUNICIPAL SOLID WASTE LANDFILL LEACHATE.
Cornell Univ., Ithaca, NY. Center for Environ-

mental Research.
For primary bibliographic entry see Field 5D.
W90-04413

USE OF WETLANDS FOR URBAN STORMWATER MANAGEMENT.
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W90-04414

USE OF WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT AND DISPOSAL: REGULATORY ISSUES AND EPA POLICIES.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
For primary bibliographic entry see Field 5G.
W90-04415

STATES' ACTIVITIES, ATTITUDES AND POLICIES CONCERNING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Div. of Water Pollution Control, Nashville.
For primary bibliographic entry see Field 5G.
W90-04416

HUMAN PERCEPTION OF UTILIZATION OF WETLANDS FOR WASTE ASSIMILATION, OR HOW DO YOU MAKE A SILK PURSE OUT OF A SOW'S EAR.
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 6B.
W90-04417

PRELIMINARY CONSIDERATIONS REGARDING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Office of Surface Mining Reclamation and Enforcement (DI), Pittsburgh, PA. Eastern Field Operations.
For primary bibliographic entry see Field 5D.
W90-04418

SELECTION AND EVALUATION OF SITES FOR CONSTRUCTED WASTEWATER TREATMENT WETLANDS.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D.
W90-04419

PERFORMANCE EXPECTATIONS AND LOADING RATES FOR CONSTRUCTED WETLANDS.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04420

ANCILLARY BENEFITS OF WETLANDS CONSTRUCTED PRIMARILY FOR WASTEWATER TREATMENT.
Western Illinois Univ., Macomb. Inst. for Environmental Management.
For primary bibliographic entry see Field 5D.
W90-04421

OVERVIEW FROM DUCKS UNLIMITED, INC.
Ducks Unlimited, Inc., Bismarck, ND. Great Plains Regional Office.
For primary bibliographic entry see Field 5D.
W90-04422

CONFIGURATION AND SUBSTRATE DESIGN CONSIDERATIONS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04423

HYDRAULIC DESIGN CONSIDERATIONS AND CONTROL STRUCTURES FOR CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04424

CALIFORNIA'S EXPERIENCE WITH MOSQUITOES IN AQUATIC WASTEWATER TREATMENT SYSTEMS.
California State Water Resources Control Board, Sacramento.
For primary bibliographic entry see Field 5D.
W90-04425

CONSTRUCTING THE WASTEWATER TREATMENT WETLAND: SOME FACTORS TO CONSIDER.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5D.
W90-04426

CONSIDERATIONS AND TECHNIQUES FOR VEGETATION ESTABLISHMENT IN CONSTRUCTED WETLANDS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5D.
W90-04427

OPERATIONS OPTIMIZATION.
CH2M Hill, Inc., Portland, OR.
For primary bibliographic entry see Field 5D.
W90-04428

PATHOGEN REMOVAL IN CONSTRUCTED WETLANDS.
San Diego State Univ., CA. Graduate School of Public Health.
For primary bibliographic entry see Field 5D.
W90-04429

MONITORING OF CONSTRUCTED WETLANDS FOR WASTEWATER.
Environmental Protection Agency, Athens, GA. Environmental Services Div.
For primary bibliographic entry see Field 5D.
W90-04430

DECOMPOSITION IN WASTEWATER WETLANDS.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
For primary bibliographic entry see Field 5D.
W90-04431

THERMOOSMOTIC AIR TRANSPORT IN AQUATIC PLANTS AFFECTING GROWTH ACTIVITIES AND OXYGEN DIFFUSION IN WETLAND SOILS.
Cologne Univ. (Germany, F.R.). Botanical Inst.
W. Grosse.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 469-476, 5 fig, 12 ref.

Descriptors: *Wetlands, *Limnology, *Aquatic plants, *Plant physiology, *Oxygen, Diffusion, Thermoosmosis, Plant growth, Mass transport, Macrophytes, Ecology, Water lilies, Lake sediments, Oxygenation, Aerobic conditions.

Many wetland species are cultivated in lakes and constructed ponds as ornamental plants. These plants supply their rhizomes and roots growing in anoxic sediments of the lake with atmospheric oxygen to sustain growth activities in submerged organs. Transport of oxygen in these plants is accomplished by thermoosmosis (TO). TO occurs when a temperature increase in a compartment causes a net flow of gas to another compartment as the system seeks a steady state. The resulting higher pressure in the warmer compartment can be used to initiate a flow of gas through an additional channel back to the cooler compartment. Aquatic plants with floating leaves, as well as alder (Alnus glutinosa) are capable of generating a circulating gas flow by TO. Plants in which TO has been measured include Nuphar luteum (yellow water lily), Nymphoides peltata (fringed water lily), Nelumbo nucifera (sacred lotus), Victoria amazonica (Amazon water lily), and alder. The ecological significance of gas transport by TO for plant inhabiting aqueous environments lies in the increase in supply of oxygen to the root and rhizome apices. In addition to supporting the metabolism of roots, this gas transport may benefit the surrounding sedimentary environment by enriching the rhizosphere with oxygen. Oxygen diffusion from roots into the sediment is suggested by the deposits of Fe(3+) hydroxide often observed near the root surface. Gas bubbles containing 1-6 volume percent O2 observed at the roots of alder trees under thermoosmotic conditions indicate that a flow of gas out of the roots occurs. About 14-21 micromol O2/hr exits the root system of 1-yr-old alder at 5 C; this flow declines to 0-3 micromol O2/hr when gas transport to the roots is stopped. Gas transport by TO will enhance the formation of oxygenated zones in sediments of deeper lakes or water clearing ponds used for water purification. (See also W90-04392) (Rochester-PTI)
W90-04432

NITRIFICATION AND DENITRIFICATION AT ISELIN MARSH/POND/MEADOW FACILITY.
Moon Township Municipal Authority, Coraopolis, PA.
For primary bibliographic entry see Field 5D.
W90-04433

DENITRIFICATION IN ARTIFICIAL WETLANDS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Biotechnologie.
For primary bibliographic entry see Field 5D.
W90-04434

NITROGEN REMOVAL FROM FRESHWATER WETLANDS: NITRIFICATION-DENITRIFICATION COUPLING POTENTIAL.
Florida Agricultural and Mechanical Univ., Tallahassee. Wetland Ecology Program.
For primary bibliographic entry see Field 5D.
W90-04435

RELATIVE RADIAL OXYGEN LOSS IN FIVE WETLAND PLANTS.
Oak Ridge National Lab., TN.
S. C. Michaud, and C. J. Richardson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 501-507, 1 fig, 2 tab, 17 ref.

Descriptors: *Oxygen depletion, *Limnology, *Wetlands, *Plant physiology, *Aquatic plants, Macrophytes, Radial oxygen loss, Rhizosphere, Cattails, Burreed, Spikerush, Woolgrass, Rushes, Wastewater treatment, Biological wastewater treatment, Water pollution control, Artificial wetlands, Hydrogen sulfide.

Oxygen diffusion to root tips is one of the physiological characteristics that permit wetland species to exist in flooded conditions. Diffuse O2 not only supplies the roots but can oxidize the surrounding soil; the process has been termed radial oxygen loss (ROL). The present study had the following objectives: (1) to develop a method to test for the presence of O2 diffusion from the roots of plants; to determine species differences in O2 loss to sediments; and (3) to recommend plant species for use in constructed wetlands to maximize O2 concentrations in the root zone. Plants were collected from a constructed wastewater treatment wetland that receives effluent from a slurry pond. After

cleaning, the plants were immersed in deoxygenated water supplemented with H2S to reduce the solution Eh below -250 mV. Indigo carmine dye in the deoxygenated solution was used to indicate the amount of oxygen exiting from the plant roots at 6, 12, and 24 hr (by spectrophotometry of samples). Five species of plants were studied: cattail (Typha latifolia); burreed (Sparganium americanum); spikerush (Eleocharis quadrangulata); woolgrass (Scirpus cyperinus); and rush (Juncus effusus). Oxygen output varied according to the plant species, indicating that similar variations could occur in the soil matrix. Oxidation of toxic metals could be optimized by selection of appropriate plants. The ROL experiments showed the following order of oxygen output (per unit biomass basis): cattail > rush > burreed > spikerush > woolgrass. However, individual growth characteristics, such as stand density, need to be considered when comparing ROL performance as a management tool. (See also W90-04392) (Rochester-PTT)
W90-04436

POTENTIAL IMPORTANCE OF SULFATE REDUCTION PROCESSES IN WETLANDS CONSTRUCTED TO TREAT MINE DRAINAGE.
Bureau of Mines, Pittsburgh, PA.
For primary bibliographic entry see Field 5D.
W90-04437

EVALUATION OF SPECIFIC MICROBIOLOGICAL ASSAYS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT MANAGEMENT.
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5D.
W90-04438

SECONDARY TREATMENT OF DOMESTIC WASTEWATER USING FLOATING AND EMERGENT MACROPHYTES.
Reedy Creek Utilities Co., Inc., Lake Buena Vista, FL.
For primary bibliographic entry see Field 5D.
W90-04439

AMPLIFICATION OF TOTAL DRY MATTER, NITROGEN AND PHOSPHORUS REMOVAL FROM STANDS OF PHRAGMITES AUSTRALIS BY HARVESTING AND REHARVESTING REGENERATED SHOOTS.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5D.
W90-04440

AQUATIC PLANT CULTURE FOR WASTE TREATMENT AND RESOURCE RECOVERY.
National Fertilizer Development Center, Muscle Shoals, AL.
For primary bibliographic entry see Field 5D.
W90-04442

BACTERIOLOGICAL TESTS FROM THE CONSTRUCTED WETLAND OF THE BIG FIVE TUNNEL, IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 5D.
W90-04443

USE OF PERIPHYTON FOR NUTRIENT REMOVAL FROM WATERS.
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5G.
W90-04444

DANISH EXPERIENCE WITH SEWAGE TREATMENT IN CONSTRUCTED WETLANDS.
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5D.
W90-04445

MAN-MADE WETLANDS FOR WASTEWATER TREATMENT: TWO CASE STUDIES.
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.
For primary bibliographic entry see Field 5D.
W90-04446

RESEARCH TO DEVELOP ENGINEERING GUIDELINES FOR IMPLEMENTATION OF CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT IN SOUTHERN AFRICA.
Steffen, Robertson and Kirsten, Inc., Johannesburg (South Africa).
For primary bibliographic entry see Field 5D.
W90-04447

CONSTRUCTED WETLANDS: DESIGN, CONSTRUCTION AND COSTS.
Dames and Moore, Boston, MA.
For primary bibliographic entry see Field 5D.
W90-04448

WASTEWATER TREATMENT/DISPOSAL IN A COMBINED MARSH AND FOREST SYSTEM PROVIDES FOR WILDLIFE HABITAT AND RECREATIONAL USE.
James Engineering, Inc., El Cerrito, CA.
For primary bibliographic entry see Field 5D.
W90-04449

ROOT-ZONE SYSTEM: MANNERSDORF. NEW RESULTS.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
For primary bibliographic entry see Field 5D.
W90-04450

CONSTRUCTED WETLANDS FOR SECONDARY TREATMENT.
Nolte (George S.) and Associates, Sacramento, CA.
For primary bibliographic entry see Field 5D.
W90-04451

HYDRAULIC CONSIDERATIONS AND THE DESIGN OF REED BED TREATMENT SYSTEMS.
Water Research Centre, Stevenage (England).
For primary bibliographic entry see Field 5D.
W90-04452

USE OF ARTIFICIAL CATTAIL MARSHES TO TREAT SEWAGE IN NORTHERN ONTARIO, CANADA.
Hanna (J.E.) Associates, Inc., Pickering (Ontario).
For primary bibliographic entry see Field 5D.
W90-04453

SOME ANCILLARY BENEFITS OF A NATURAL LAND TREATMENT SYSTEM.
Grand Strand Water and Sewer Authority, Conway, SC.
For primary bibliographic entry see Field 5D.
W90-04454

PERFORMANCE OF SOLID-MATRIX WETLAND SYSTEMS, VIEWED AS FIXED-FILM BIOREACTORS.
Hawkesbury Agricultural Coll., Richmond (Australia). Faculty of Food and Environmental Sciences.
For primary bibliographic entry see Field 5D.
W90-04455

FATE OF MICROBIAL INDICATORS AND VIRUSES IN A FORESTED WETLAND.
East Tennessee State Univ., Johnson City. Dept. of Environmental Health.
For primary bibliographic entry see Field 5D.
W90-04456

WASTEWATER WETLANDS: USER FRIENDLY MOSQUITO HABITATS.
Marin Sonoma Mosquito Abatement District, Petaluma, CA.
For primary bibliographic entry see Field 5D.
W90-04457

URBAN RUNOFF TREATMENT IN A FRESH/BRACKISH WATER MARSH IN FREMONT, CALIFORNIA.
Association of Bay Area Governments, Oakland, CA.
For primary bibliographic entry see Field 5D.
W90-04459

DESIGN OF WET DETENTION BASINS AND CONSTRUCTED WETLANDS FOR TREATMENT OF STORMWATER RUNOFF FROM A REGIONAL SHOPPING MALL IN MASSACHUSETTS.
IEP, Inc., Northborough, MA.
For primary bibliographic entry see Field 5D.
W90-04460

CREATION OF WETLANDS FOR THE IMPROVEMENT OF WATER QUALITY: A PROPOSAL FOR THE JOINT USE OF HIGHWAY RIGHT-OF-WAY.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Liaison Office.
For primary bibliographic entry see Field 5G.
W90-04461

WETLANDS TREATMENT OF DAIRY ANIMAL WASTES IN IRISH DRUMLIN LANDSCAPE.
Lough Gara Farms Ltd., Boyle (Ireland).
For primary bibliographic entry see Field 5D.
W90-04462

POTENTIAL ROLE OF MARSH CREATION IN RESTORATION OF HYPERTROPHIC LAKES.
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 5G.
W90-04463

EXPERIMENTS IN WASTEWATER POLISHING IN CONSTRUCTED TIDAL MARSHES: DOES IT WORK. ARE THE RESULTS PREDICTABLE.
Lehigh Univ., Bethlehem, PA. Center for Marine and Environmental Studies.
For primary bibliographic entry see Field 5D.
W90-04465

POTENTIAL USE OF CONSTRUCTED WETLANDS TO TREAT LANDFILL LEACHATE.
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 5D.
W90-04466

DESIGN AND CONSTRUCTION OF A RESEARCH SITE FOR PASSIVE MINE DRAINAGE TREATMENT IN IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 5D.
W90-04469

MANGANESE AND IRON ENCRUSTATION ON GREEN ALGAE LIVING IN ACID MINE DRAINAGE.
Memphis State Univ., TN. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-04470

USE OF WETLANDS TO REMOVE NICKEL AND COPPER FROM MINE DRAINAGE.
Minnesota Dept. of Natural Resources, St. Paul. Minerals Div.

For primary bibliographic entry see Field 5D.
W90-04472

WINDSOR COAL COMPANY WETLAND: AN OVERVIEW.
American Electric Power Corp., Lancaster, OH.
For primary bibliographic entry see Field 5D.
W90-04473

WETLAND TREATMENT OF COAL MINE DRAINAGE: CONTROLLED STUDIES OF IRON RETENTION IN MODEL WETLAND SYSTEMS.
Villanova Univ., PA. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-04474

TOLERANCE OF THREE WETLAND PLANT SPECIES TO ACID MINE DRAINAGE: A GREENHOUSE STUDY.
Pennsylvania State Univ., University Park. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-04475

CONTROL OF ARMYWORM, SIMYRA HENRICI (LEPIDOPTERA: NOCTUIDAE), ON CATTAIL PLANTINGS IN ACID DRAINAGE TREATMENT WETLANDS AT WIDOWS CREEK STEAM-ELECTRIC PLANT.
Tennessee Valley Authority, Muscle Shoals, AL. Vector and Plant Management Program.
For primary bibliographic entry see Field 5D.
W90-04476

QUALITATIVE AND QUANTITATIVE AQUATIC ALGAL DATA COMPILATION TO DETERMINE MACROTRENDS-III.
Arkansas Univ., Fayetteville. Dept. of Botany and Microbiology.
R. L. Meyer.
Arkansas Water Resources Research Center, University of Arkansas, Fayetteville, AR. Publication No. 126, June 1987. 7p. 6 ref.

Descriptors: *Limnology, *Databases, *Algae, *Species composition, *Data collections, *Data storage and retrieval, Taxonomy, Ecological distribution, Cyanophyta, Arkansas.

A data base of the algae of Arkansas ecoregions has been established by the use of a relational data base management system (dBase III plus). The system was chosen to be readily available for a variety of microcomputers using MS-DOS and PC-DOS. The data base contains taxonomic fields from division through variety, synonymy, authors, initial description, date and definitive descriptive source. The data are cross-referenced by ecoregion, Round's community and subcommunity designations. The data base contains approximately 1,500 taxonomic records in all divisions and classes of freshwater algae. The data are sortable by any of the included parameters. The data have been used to initiate the publication of the algal flora of Arkansas. The listing of the Cyanophyta/Cyanobacteria or blue-green algae is presently available. Other taxonomic lists are in preparation. (Author's abstract)
W90-04492

2I. Water In Plants

PLANT ECOLOGICAL ASPECTS OF FLOOD GEOMORPHOLOGY AND PALEOFLOOD HISTORY.
Geological Survey, Nashville, TN.
For primary bibliographic entry see Field 2E.
W90-03681

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, APRIL 9, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03880

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, JUNE 16, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03881

USE OF AQUATIC MACROPHYTES IN WATER-POLLUTION CONTROL.
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5D.
W90-04003

COMPARISON OF SOME LIMNOLOGICAL VARIABLES IN THE WATERS BETWEEN THE UPPER AND LOWER LITTORAL AREAS WITHIN AN EGERIA STAND.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
For primary bibliographic entry see Field 2H.
W90-04075

EARLY MORNING CANOPY TEMPERATURES FOR EVALUATING WATER STRESS IN A WHEAT CROP.
San Diego State Univ., CA. Dept. of Geography.
For primary bibliographic entry see Field 3F.
W90-04204

WETLANDS: THE LIFEBLOOD OF WILDLIFE.
National Wildlife Federation, Washington, DC. Fisheries and Wildlife Div.
For primary bibliographic entry see Field 2H.
W90-04399

THERMOOSMOTIC AIR TRANSPORT IN AQUATIC PLANTS AFFECTING GROWTH ACTIVITIES AND OXYGEN DIFFUSION IN WETLAND SOILS.
Cologne Univ. (Germany, F.R.). Botanical Inst.
For primary bibliographic entry see Field 2H.
W90-04432

RELATIVE RADIAL OXYGEN LOSS IN FIVE WETLAND PLANTS.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 2H.
W90-04436

2J. Erosion and Sedimentation

SEDIMENTATION PROCESSES.
Alaska Univ., Fairbanks. Inst. of Marine Science.
A. S. Naidu, and L. H. Klein.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 69-91, 4 tab, 49 ref. US Bureau of Mines Contracts TAPS/41 and 80221062.

Descriptors: *Sedimentation, *Fjords, *Sediment transport, *Trace metals, *Arctic zone, *Alaska, *Valdez, Clays, Mineralogy, Geochemistry, Literature review, Glacial sediments, Sediment contamination, Organic carbon, Metals, Seawater, Alaska pipeline, Path of pollutants.

Many long-term investigations have been pursued on various aspects of sedimentation of the fjords in south-central and southeast Alaska, including studies on sediment transport and dynamics, clay mineralogy, and sediment geochemistry. This chapter furnishes an overview, based on published and unpublished data on the lithological and chemical compositions of contemporary periglacial sediments of Port Valdez and Valdez Arm, and discusses the sediment characteristics, sediment mass balance, organic carbon flux and metal partitioning in sediments, and results of some pollution-related geochemical studies. Between 20% and 40% of the gross concentrations of Zn, Co, Cu, Ni, and 75% of the total Fe are extractable from Port Valdez sediments, while the rest is bound in the crystal-lattice. The area has been increasingly subjected to activities related to the export of crude oil from the Alaska pipeline. Several studies have been conducted, both of the sediment and the seawater. All of the studies suggest that Port Valdez has remained essentially a clean environment with respect to trace metals. (See also W89-03610) (Lantz-PTT)
W90-03614

INTERNATIONAL CONFERENCE ON RIVER REGIME.
For primary bibliographic entry see Field 2E.
W90-03626

DIMENSIONAL AND DIMENSIONLESS REGIME EQUATIONS FOR GRAVEL-BED RIVERS.
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03627

DOWNSTREAM HYDRAULIC GEOMETRY OF NONCOHESIVE ALLUVIAL CHANNELS.
Colorado State Univ., Fort Collins. Engineering Research Center.
For primary bibliographic entry see Field 2E.
W90-03628

DYNAMIC ADJUSTMENTS OF CHANNEL WIDTH AND SLOPE.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 2E.
W90-03629

PREDICTION OF HYDRAULIC GEOMETRY OF GRAVEL-BED STREAMS USING THE MINIMUM STREAM POWER CONCEPT.
Queen Mary Coll., London (England).
For primary bibliographic entry see Field 2E.
W90-03630

REGIME RELATIONS BASED ON DISPERSIVE-FORCE CONCENTRATION PROFILES.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03631

REGIME CHANNELS OF AN EXTREMELY ARID ZONE.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03632

APPLICATION OF REGIME THEORY TO WADI CHANNELS IN DESERT CONDITIONS.
Binnie and Partners, Redhill (England).
For primary bibliographic entry see Field 2E.
W90-03633

CAUSE OF RIVER MEANDERING.
San Diego State Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03634

STABILITY OF INITIALLY STRAIGHT RIVERS.
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 2E.
W90-03635

THRESHOLD BETWEEN MEANDERING AND BRAIDING.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
For primary bibliographic entry see Field 2E.
W90-03636

ABOUT EXTREMAL HYPOTHESES AND RIVER REGIME.
Bologna Univ. (Italy). Ist. di Geologia.
For primary bibliographic entry see Field 2E.
W90-03637

INFLUENCE OF BANK STABILITY ON REGIME GEOMETRY OF NATURAL CHANNEL.
Queen Mary Coll., London (England).
For primary bibliographic entry see Field 2E.
W90-03638

WIDTH OF REGIME CHANNELS.
For primary bibliographic entry see Field 2E.
W90-03639

EFFECTS OF GRADATION OF BED MATERIALS AND TRANSPIRATION THROUGH A BED ON BED LOAD TRANSPORT.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03640

CHARACTERISTICS OF FLOW AT THE INTERSECTION OF RIVER MEANDERS AND FLOOD RELIEF (CUT-OFF) CHANNELS.
Glasgow Univ. (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03642

REGIME BED SLOPES OF CHANNELS WITH A BUOYANT BOUNDARY.
Windsor Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03643

SEDIMENT SIZE AND CHANNEL CHANGES IN BRAIDED AND MEANDERING GRAVEL-BED STREAMS, UPPER DEESIDE, SCOTLAND.
Aberdeen Univ. (Scotland). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03644

CHANGE OF RIVER REGIME AND GRADED-SEDIMENT DISCHARGE DURING FLOOD.
Tottori Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03645

STUDY ON THE STAIRCASE PROFILE AND ARMOURING EFFECTS OF RIVER BED FOR TORRENTIAL STREAMS IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Dept. of Soil and Water Conservation.
For primary bibliographic entry see Field 2E.
W90-03646

PREDICTION OF MEAN BED AND WALL BOUNDARY SHEAR IN UNIFORM AND COMPOSITELY ROUGH CHANNELS.
Leicester Univ. (England). Dept. of Engineering.
For primary bibliographic entry see Field 2E.
W90-03648

MULTIPLE BARS AND STREAM BRAIDING.
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2E.
W90-03649

BED FORM CONFIGURATION OF A RIVER BEND.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03650

REGIME ASPECTS OF FLOOD CONTROL CHANNELIZATION.
Northwest Hydraulic Consultants Ltd., Edmonton (Alberta).
For primary bibliographic entry see Field 4A.
W90-03651

INFLUENCE OF RIVER REGIME ON THE FLOOD MANAGEMENT OF SUKKUR BARRAGE, PAKISTAN.
For primary bibliographic entry see Field 5E.
W90-03652

APPLICATION OF BED STABILITY CRITERIA IN RIVERS WITH CONSECUTIVE RUN-OF-RIVER POWER PLANTS.
For primary bibliographic entry see Field 2E.
W90-03653

REGIME CHANGES IN THE CALEDON RIVER ASSOCIATED WITH SEDIMENT DEPOSITION UPSTREAM OF WELBEDACHT BARRAGE.
Pretoria Univ. (South Africa). Dept. of Civil Engineering.
A. Rooseboom, and S. J. van Vuuren.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. 365-374, 5 fig, 5 ref.

Descriptors: *Regime streams, *Reservoir storage, *South Africa, *Sediment transport, Model studies, Sediment deposition, Flow pattern, Reservoir operation, Flood-control storage.

Different modelling techniques have been used to predict further deposition upstream of Welbedacht Reservoir in South Africa, which has lost two-thirds of its capacity within fourteen years. Historical records, empirical extrapolation, mathematical modelling and a physical model have been used in the predictions. The 'modelled' and 'empirical' values agree well from 1983 onwards. The deviation prior to 1983 was attributed to exceptionally high sediment loads during 1974. The equilibrium shape of the bed profile was calculated by means of a special backwater program which not only balances the energy equation but also fills in the bed up to the level where equilibrium exists. It is then possible to predict what the longitudinal bed slope of the lower basin region will be. Further upstream, the very high sediment levels lead to very wide beds and ill-defined flow patterns. The amount of storage space which could be maintained in the future will depend on the magnitude of minimum shear velocities which can be maintained within the reservoir under flood conditions. If the reservoir level is kept at Full Supply Level in the future, according to the mathematical models, less than 5,000,000 cu m of storage space will be maintained. These analyses indicate that 10,000,000 cu m of storage space could be retained if all incoming floods were passed through with the gates fully opened. Physical model studies have confirmed the results of the mathematical models. (See also W90-03626) (White-Reimer-PTT)
W90-03654

REGIME CHANGES IN THE CALEDON RIVER ASSOCIATED WITH WELBEDACHT BARRAGE: PHYSICAL MODEL, PROTOTYPE AND THEORETICAL CORRELATIONS.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 2E.
W90-03655

EFFECTS OF EXTENSIVE DREDGING ON THE RIVER REGIME.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2E.
W90-03656

EFFECT OF BOAT TRAFFIC ON RIVER REGIME.
Forth River Purification Board, Edinburgh (Scotland).
For primary bibliographic entry see Field 2E.
W90-03657

USE OF AN EMPIRICAL METHOD (EROSION POTENTIAL METHOD) FOR CALCULATING SEDIMENT PRODUCTION AND TRANSPORTATION IN UNSTUDIED OR TORRENTIAL STREAMS.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
Z. Gavrilovic.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 411-422, 5 fig, 4 tab, 8 ref.

Descriptors: *Erosion, *Sediment transport, *Reservoir silting, *Stream erosion, Erosion Potential Method, Topography, Climates, Empirical methods, Mathematical equations, Feasibility studies.

The Erosion Potential Method can be used to estimate erosion in catchment areas and sediment transport to a discharge point, or to a river section. The method is based on the identification of specific situations and erosion interactions, topographic features, and general climatic characteristics. While it requires some field investigation, the method is incomparably faster than long-term observations. This method has proved reliable when used in preliminary estimates of average annual amounts of sediment load at potential or actual reservoir sites, regulated rivers or structures. In order to use this method erosion plots on slopes at equal angles and on homogeneous rock foundations must be formed under a variety of land uses. Through means of research and field investigations data is collected and used to calculate the erosion coefficient, the coefficient of the observed erosion process, the land use coefficient, and the coefficient of soil resistance. These coefficients form the basis for the calculation of the erosion coefficient which is used for the classification of erosion and the estimate of erosion production. In instances where the preliminary estimate of the sediment production and discharge was made using the erosion potential method, significant investments in dam construction were avoided for storage reservoirs that would soon have become ineffective due to filling from eroded sediments. (See also W90-03626) (White-Reimer-PTT)
W90-03658

EARTHQUAKES AND RIVER REGIMES.
Central Water and Power Research Station, Poona (India).
For primary bibliographic entry see Field 2E.
W90-03659

REGIME THEORY AND ENVIRONMENTAL CHANGE-IRRECONCILABLE CONCEPTS.
University Coll. of Wales, Aberystwyth. Dept. of Geography.
J. Lewin, M. G. Macklin, and M. D. Newson.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. p 431-445, 8 fig, 2 tab, 34 ref.

Descriptors: *Sediment concentration, *Hydrological regime, *Regime streams, *Channel morphology, *England, Gravel-bed streams, Dynamic equilibrium, Alluvial rivers, Case studies, River basin development, Engineering.

Regime theory as used in river engineering makes the assumptions of dynamic equilibrium; however, both intrinsic and extrinsic factors in gravel-bed rivers lead to channel instability which undermines engineering design/structures. Recent alluvial histories of the Rivers Nent and West Allen in the South Tyne basins show the extended time scales

over which adjustment to new equilibrium condition following environmental change may take place. In addition, many river systems in the Northern Pennines, or other areas of metal mining in upland Britain, are still undergoing changes in channel morphology, readjusting to new rates of sediment supply, fifty years after the cessation of mining. The Rheidol and Ystwyth appear to be still adjusting to altered sediment supply. The morphology of these alluvial rivers can best be regarded as equilibrating rather than as having actually achieved a state of equilibrium. It is of particular importance for engineers managing river systems to establish whether a river is adjusted or adjusting, and the probable nature and magnitude of future channel change. It is suggested that engineers need to accept that river form will change during the lifetime of a project if the form is not controlled. (See also W90-03626) (White-Reimer-PTT)
W90-03660

FLOOD GEOMORPHOLOGY.
For primary bibliographic entry see Field 2E.
W90-03661

FLOOD CLIMATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03662

DRAINAGE BASIN MORPHOMETRY AND FLOODS.
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03664

GEOMORPHIC MEASUREMENTS AFTER A FLOOD.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2E.
W90-03665

FLOOD EROSION.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-03666

SEDIMENT TRANSPORT BY FLOODS.
Oregon State Univ., Corvallis. Coll. of Oceanography.
For primary bibliographic entry see Field 2E.
W90-03667

RHEOLOGIC, GEOMORPHIC, AND SEDIMENTOLOGIC DIFFERENTIATION OF WATER FLOODS, HYPERCONCENTRATED FLOWS, AND DEBRIS FLOWS.
Cascades Volcano Observatory, Vancouver, WA.
For primary bibliographic entry see Field 2E.
W90-03668

FLOOD SEDIMENTATION IN BEDROCK FLUVIAL SYSTEMS.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-03669

RIVER FLOOD REGIME AND FLOODPLAIN STRATIGRAPHY.
Wright State Univ., Dayton, OH. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W90-03670

FLOODS; DEGRADATION AND AGGRADATION.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-03671

GEOMORPHIC IMPACT OF LARGE FLOODS: REVIEW AND NEW PERSPECTIVES ON MAGNITUDE AND FREQUENCY.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W90-03672

DEFINITION OF FLOOD PLAINS ALONG ARID-REGION RIVERS.
Arizona State Univ., Tempe. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03675

FLOODPLAIN EROSION AND DEPOSITION DURING THE DECEMBER 1982 FLOODS IN SOUTHEAST MISSOURI.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W90-03676

GEOMORPHIC RESPONSE OF STREAMS TO FLOODS IN THE GLACIATED TERRAIN OF SOUTHERN NEW ENGLAND.
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
For primary bibliographic entry see Field 2E.
W90-03677

LARGE FLOODS AS GEOMORPHIC EVENTS IN THE HUMID TROPICS.
National Univ. of Singapore. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03679

PALEOFLUVIAL ESTIMATES FROM DIMENSIONS OF FORMER CHANNELS AND MEANDERS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2E.
W90-03680

PLANT ECOLOGICAL ASPECTS OF FLOOD GEOMORPHOLOGY AND PALEOFLOOD HISTORY.
Geological Survey, Nashville, TN.
For primary bibliographic entry see Field 2E.
W90-03681

PALEOFLOOD ANALYSIS USING SLACKWATER DEPOSITS.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W90-03682

HISTORICAL CHANGE OF LARGE ALLUVIAL RIVERS: WESTERN EUROPE.
For primary bibliographic entry see Field 2E.
W90-03689

EVIDENCE FOR HISTORICAL HEAVY METAL POLLUTION IN FLOODPLAIN SOILS: THE MEUSE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 5B.
W90-03697

LOWER RHINE GEOMORPHOLOGICAL CHANGES.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 2E.
W90-03699

CHANNEL STABILITY OF SELECTED STREAMS IN NORTHERN MISSISSIPPI.
Geological Survey, Jackson, MS.
K. V. Wilson, and D. P. Turnipseed.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 104-111. 5 fig, 22 ref.

Descriptors: *Mississippi, *Channel stability, *Channel morphology, *Channel erosion, *Channel improvement, *Streambeds, Stream banks, Stream upflow, Channel scour, Stream degradation, Regression analysis, Riparian vegetation, Aggradation, Alluvial rivers, Erosion plates.

The results of a study of channel stability is presented for selected sites on alluvial streams in northern Mississippi. The major objectives of the study were to: (1) identify channel instability, (2) estimate the amounts of near-future channel-bed degradation or aggradation and channel-bank widening or accretion, and (3) to describe the expected stable channel geometry at sites undergoing channel adjustment. The stability of channel beds and banks was assessed by determining the ages, types, and growth patterns of trees on channel banks, obtaining bulk unit weights and shear-strength properties of bank materials, and surveying channel cross sections and profiles. The potential for near-future degradation was estimated by log-linear regression of channel-bed elevations over time since the channel was modified. Channel geometry, shear-strength properties and log-linear regression of channel bank widths over time were used for potential for channel-bank failure. Overall, it was concluded that modifications on alluvial channels studied in northern Mississippi have resulted in unstable channel gradients and bank conditions. The channels have degraded as much as 14 ft below the modified channel-bed elevation and widened as much as 7 times the modified width. Channel adjustments along or upstream from some modified stream reaches continue to result in property loss and endanger bridge structures. Some channels could degrade up to 3 ft and widen up to 40 ft in the near future. Channel-bed and channel-bank adjustments in the past are assumed to be representative of probable processes in the near future; however, additional channel modifications or unusually large, destructive flooding could begin other channel adjustment processes. (See also W90-03708) (Friedmann-PTT)
W90-03726

DETECTION OF COARSE SEDIMENT MOVEMENT USING RADIO TRANSMITTERS.
Army Cold Regions Research and Engineering Lab., Fort Wainwright, AK. Alaskan Projects Office.
For primary bibliographic entry see Field 7B.
W90-03821

GRAVEL TRANSPORT IN THE BRAIDED WAIMAKARIRI RIVER: MECHANISMS, MEASUREMENTS AND PREDICTIONS.
Carson (M.A.) and Associates, Victoria (British Columbia).
M. A. Carson, and G. A. Griffiths.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 201-220, August 1989. 9 fig, 2 tab, 15 ref.

Descriptors: *Bed load, *Sediment transport, *Alluvial channels, *Gravel, *Channel morphology, *Suspended load, *Sediment yield, *Braided streams, Scour, Channel scour, Sedimentation, Mathematical studies.

Yields of gravel bed load on the braided lower Waimakariri River in New Zealand were investigated by several methods and for different timescales: short-term several months), medium-term (several years) and long-term (1967-1983). Short-term estimates of gravel yield were made for five such periods in 1986-87 by a morphological method. Bed morphology in a selected reach was mapped before and after flood events, the gross volume of scour in that time period measured, and a mean transport rate through the reach computed on the basis of the step distance of gravel movement from scour zones to areas of accretion. The findings indicate that a considerable fraction of the annual gravel load is derived from scour of braid banks, with the gravel being shunted downstream from one zone of temporary storage to another.

Computation of bed load yields during the same period by the Meyer-Peter and Muller (MPM) equation revealed excellent agreement with the morphological estimated. Comparison of the MPM prediction, based on flow duration data for 1967-1983 also showed excellent agreement with the long-term rate, assessed by stadia survey of cross-sections in the reach of accumulation downstream of the study reach. Predictions using the MPM formula for the medium-term however, while acceptable, showed greater differences form the surveyed rates. Evidence indicates that this is related to highly dynamic bed conditions in which the availability of more mobile, finer-grained gravel in the reach changes from year to year, as slugs of such sediment move intermittently downstream. Thus, while prediction of a short-term yield (based on bed conditions at the time of study) and a long-term yield based on temporal mean conditions as inferred from bed conditions averaged along the river) are realistic goals, the accurate prediction of successive short-term or medium-term yields seems to be impossible, unless detailed analysis of bed conditions (especially grain size) is undertaken in each time period, which is a major task. (Author's abstract)
W90-03903

EFFECTS OF SUSPENDED SEDIMENTS ON EGG PRODUCTION OF THE CALANOID COPEPOD ACARTIA TONSA.

Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
J. R. White, and M. J. Dagg.

Marine Biology MBIOAJ, Vol. 102, No. 3, p 315-319, September 1, 1989. 3 fig, 1 tab, 21 ref. Louisiana Sea Grant College Program Project R/MPE-34.

Descriptors: *Estuaries, *Suspended sediments, *Eggs, *Spawning, *Copepods, Louisiana, Phytoplankton, Sediment concentration, Food chains, Food habits, Estuarine sediments, Reproduction rates.

The estuarine copepod Acartia tonsa was collected on several occasions between 4 April and 14 August 1985 from Terrebonne Bay, Louisiana (29 deg 08 min N; 90 deg 36 min W) and the effects of suspended sediments, collected from the same area, on its diet were measured. Measurements were made at five different concentrations of sediment (100 to 1000 ppm) and six phytoplankton concentrations (500 to 13,000 cells/ml Thalassiosira weissflogii). Egg production rate was used as an index of diet quality. At low phytoplankton concentrations (500 cells/ml), and at intermediate concentrations (2000 cells/ml) for previously-starved copepods, egg production was reduced by up to 40% at a sediment concentration of 250 ppm and further reduced at higher sediment concentrations. At higher food concentrations (4000 to 13000 cells/ml), suspended sediment had no effect on egg production rates at sediment concentrations up to 500 ppm. Rates were reduced only at the highest sediment concentration of 1000 ppm. Under most natural conditions, suspended sediment would not significantly affect egg production rates in A. tonsa. (Author's abstract)
W90-03918

DYNAMICS AND SEDIMENTOLOGY OF THE DEPOSITS OF THE FLOOD IN THE LOWER STRETCH OF THE JUCAR RIVER IN OCTOBER OF 1982 (DINAMICA Y SEDIMENTOLOGIA DE LOS DEPOSITOS DE LA AVENIDA DEL RIO JUCAR EN OCTUBRE DE 1982 EN SU TRAMO BAJO).

Universidad Complutense de Madrid (Spain). Dept. of Geodynamics.
J. Martinez-Goytre, G. Garzon, and A. Arche.

Acta Geologica Hispanica, Vol. 21/22, No. 1, p 113-122, 1986/7. 9 fig, 22 ref. English summary.

Descriptors: *Sedimentology, *Alluvial deposits, *Suspended sediments, *Sediment transport, *Alluvial channels, *Sediment discharge, *Deposition, *Floods, *Spain, Sediments, Mud, Clays, Sand, Sediment sorting, Suspended load, Dam failure.

During a flood on the 19th, 20th, and 21st of October 1982 a great quantity of materials of varying grain size were deposited in the channel of the Jucar River in Spain. The alluvial valley has been divided into two clearly differentiated zones: one from the dam of Tous to the town of Antella and another from the town to the outlet in the sea at Cullera. In the first stretch two types of sediments may be distinguished: (1) the lower (corresponding to the stage before the rupture of the dam) of coarse sands and microconglomerates, with thicknesses which vary between 0.6 m and 1.6 m and (2) sequences in which the layering was parallel to the surface, which can be interpreted as caused by variations in water depth. These deposits present superficial surface erosion which distinguishes them from the other forms of conglomerates. These conglomerates have very little sandy matrix and form diverse individual sequences with decreasing grain size, probably reflecting pulses in the current. The absence of fine materials was attributed to rapid descent of the waters and infiltration through the open spaces in the conglomerates, which impeded the water's smooth runoff. In the second section, muds and clays unquestionably dominate, since the width of the alluvial channel (for 20 km), the sloping banks, and the presence of natural dikes enlarged by human action favored the stagnation of the waters for several days, which produced an almost total process of sedimentation of the fine materials. The thickness of the sediments deposited in the lower part of the river bed varied between 15 and 60 cm and they consisted of muds, clays, and fine sands with current ripples and parallel laminations. (Shidler-PTT)
W90-03927

STUDY OF THE DEPOSITIONAL ENVIRONMENTS OF THE DELTA OF THE EBRO BY MENAS OF MOLECULAR INDICATORS (ESTUDIO DE LOS AMBIENTES DEPOSICIONALES DEL DELTA DEL EBRO MEDIANTE INDICADORES MOLECULARES).

Centro de Investigacion y Desarrollo, Barcelona (Spain). Environmental Chemistry Dept.
For primary bibliographic entry see Field 5A.
W90-03928

ENVIRONMENTS AND SUBENVIRONMENTS IN THE INTERTIDAL SECTOR OF THE BAY OF SAN SIMON; VIGO ESTUARY (PONTEVEDRA)--CHARACTERISTIC SEDIMENTARY SEQUENCES (MEDIOS Y SUBMEDIOS EN EL SECTOR INTERMAREAL DE LA ENSENADA DE SAN SIMON: RIA DE VIGO (PONTEVEDRA)--SECUENCIAS SEDIMENTARIAS CARACTERISTICAS).

Santiago Univ., Vigo (Spain).
M. A. Nombela, and F. Vilas.

Acta Geologica Hispanica, Vol. 21/22, No. 1, p 223-231, 1986/7. 9 fig, 10 ref. English summary.

Descriptors: *Estuaries, *Bays, *Estuarine sediments, *Sediment transport, *Spain, *Sediment sorting, *Intertidal areas, Salt marshes, Tidal flats, Sandbars, Geomorphology, Sedimentation, Water circulation, Tidal currents.

The San Simon Bay is situated in the inner part of the Vigo Ria on the Atlantic Coast of Spain. The entire area is dominated by tidal currents and the Oitaben/Verdugo River. The intertidal sector is formed by two very well-defined sedimentary environments: an estuary and an intertidal flat. The boundary between these environments is gradual and irregular. The subenvironments found in each of them are: salt marsh, Zostera flat, Arenicola inner flat, sand flat and the drainage channels for the intertidal zone. In the estuarine sector there is a geomorphic zonation: the inner half has transverse sandy bars and the outer half has linguoid and oblique sandy bars. There are two sequences of alternation of fine and coarse sediments which are very similar but whose origin is quite distinct: in one case, the suspension of fine sediments from the intertidal flats during extreme tides, and their later deposition over the slopes in periods of normal tides. The origin of the other type of alternating sequence is the spilling of the estuarine channel over the tidal flats. (Shidler-PTT)
W90-03929

MARINE CIRCULATION ON THE EBRO CONTINENTAL SHELF DETERMINED IN EQUAL PARTS FROM THE DISTRIBUTION OF WATER MASSES AND THE ORGANIC MICROCONTAMINANTS IN THE SEDIMENT (CIRCULACION MARINA EN LA PLATAFORMA CONTINENTAL DEL EBRO DETERMINADA A PARTIR DE LA DISTRIBUCION DE MASAS DE AGUA Y LOS MICROCONTAMINANTES ORGANICOS EN EL SEDIMENTO).

Instituto de Ciencias del Mar, Barcelona (Spain).
J. Font, A. Julia, J. Rovira, J. Salat, and J. Sanchez-Pardo.

Acta Geologica Hispanica, Vol. 21/22, No. 2, p 483-489, 1986/7. 6 fig, 13 ref. English summary.

Descriptors: *Continental shelf, *Deltas, *Estuaries, *Coastal waters, *Spain, *Water currents, *Marine sediments, *Saline-freshwater interfaces, Oceanography, Thermocline, Upwelling, Suspended load, Eddies.

The continental margin of the Ebro River delta lies in the region of the general southwestward circulation of the Northwestern Mediterranean. South of parallel 41 degrees N the continental shelf widens suddenly and causes a deflection of 90 degrees in the direction of the isobaths. The continental slope then becomes a barrier for the progression of the main current. The discharge of Ebro River waters also influences the circulation on the continental shelf. Temperature and salinity analysis of waters E and NE of the delta show an upwelling of dense waters that were circulating along the continental slope to the surface layer. The fresh waters from the river rapidly mix with surrounding waters and are transported to the south. The organic microcontaminants present in the sediment in the delta vicinity are of agricultural or industrial origin. The agricultural contaminants are due to the river discharge while the industrial discharges come with the water masses from the nearby Tarragona industrial area. The distribution patterns of substance discharged from the river show a maximum concentration NE of the delta, but not at to the mouth. These values decrease rapidly to the NE, while the gradient is gradual to the E and S. It is concluded that suspended materials from the river are trapped and sedimented in an anticyclonic vortex generated in the NE of the delta by the interaction of the main current with the coastal topography. The remaining material is spread to the S and gradually deposited on the sediment along the continental shelf in the Gulf of Valencia. (Author's abstract)
W90-03930

STUDY OF THE SUSPENDED MATERIAL IN THE GULF OF CADIZ (ESTUDIO DE LA MATERIA EN SUSPENSION EN EL GOLFO DE CADIZ).

Instituto de Ciencias del Mar, Barcelona (Spain).
A. Palanques, F. Plana, and A. Malsonado.

Acta Geologica Hispanica, Vol. 21/22, No. 2, p 491-497, 1986/7. 4 fig, 19 ref. English summary.

Descriptors: *Sediment transport, *Sedimentation, *Gulf of Cadiz, *Estuaries, *Spain, *Marine sediments, *Continental shelf, *Particulate matter, Bottom sediments, Water currents, Sedimentary petrology, Minerals, Sediment analysis, Suspended load.

The Gulf of Cadiz receives suspended particulate matter from the Guadalquivir, Tinto-Odiel and Guadiana Rivers. Inputs from atmospheric processes and from the reworking of seabed sediments may also be important. High concentrations of suspended matter from these rivers forms advective plumes that flow parallel to the coast. Settling and sedimentation of the particles on the shelf and diffusive processes lower the nepheloid concentrations with time. Apparently, there are larger amounts of particles that manage to bypass the shelf south of the Guadalquivir mouth than in the remaining areas. Shelf and slope near-bottom samples, shelf samples from the surface and intermediate sample of the south-oriented slope are made up of clay minerals, quartz, carbonate and feldspar. The samples from the surface at the continental slope stations contain large amounts of amorphous-

organic matter, some skeletal biogenic particles, some organic debris and some inorganic particles. The amount of organic debris increases toward the northwest both on the shelf and on the slope. Near-bottom deep samples from the slope have more clorite and less kaolinite than samples from the shelf. Furthermore, these samples have a relatively high content of calcite and dolomite and they have no feldspar. Particles from other source areas (Gibraltar Strait) or from the reworking of deep bottom sediments may exist in this area. (Author's abstract)
W90-03931

SPATIAL VARIATION OF THE SEDIMENT LOAD IN THE BASIN OF THE TORDERA RIVER IN LOW-WATER CONDITIONS (VARIACION ESPACIAL DE LA CARGA DE SEDIMENTOS EN LA CUENCA DEL RIO TORDERA EN CONDICIONES DE ESTIAJE).
Barcelona Univ. (Spain). Dept. de Geografia Fisica.
M. Sala, and D. Wheeler.
Acta Geologia Hispanica, Vol. 23, No. 3, p 209-216, 1988. 5 fig, 2 tab, 17 ref. English summary.

Descriptors: *Sedimentation, *Suspended load, *Sediment transport, *Low flow, *Weathering, *Spain, Dissolved solids, Streams, River basins, Alluvial deposits, Temperature effects, Lithology.

Results are presented for a study of the quantity of sediment in solution and suspension, collected from the Tordera river basin (northeastern Spain). The study was undertaken in the late summer of 1984. The sampling was carried out on the basis of the principal lithologic units of the area, in order to verify the contribution of each of them to the river load. The results confirm the importance attributable to lithology and they indicate the degree of weathering of different rocks: least in slates, somewhat greater in diorite, and high in unconsolidated sediments. Human interference was also found to be significant but only locally so. The sediment removal rates were found to be low, due to the period of low river volume in which the sampling was carried out, but were similar to those established for the British Isles, which raises the possibility that the overall averages for the Tordera may be greater than those of more humid countries. If so, it might be concluded that temperature is more important than precipitation in weathering. (Author's abstract)
W90-03932

COVARIATION OF SELECTED TRACE ELEMENTS WITH BINDING SUBSTRATES IN CORES COLLECTED FROM TWO CONTAMINATED SEDIMENTS.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W90-03939

PRACTICAL SIMULATION OF SEDIMENT TRANSPORT IN URBAN RUNOFF.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
H. O. Schroeter, and W. E. Watt.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 704-11, October 1989. 10 fig, 4 tab, 20 ref.

Descriptors: *Model studies, *Simulation analysis, *Urban runoff, *Sediment transport, *Hydrologic models, *Urban hydrology, Algorithms, Model testing, Storm runoff, Hydrologic data collections, Ontario, Canada.

A model for simulating sediment transport in urban areas has been developed based on the concept of 'equivalent solids reservoirs.' The processes of erosion, deposition, and routing have been represented by simple algorithms, which are applied to typical urban drainage elements (surfaces, gutters, pipes, and detention ponds). Input requirements are limited and include two sediment characteristics (particle size and relative density), scour and deposition parameters, and initial sediment loadings. Hydraulic properties of the drainage elements and the inflow hydrograph to each element are also required. This sediment transport submodel is an integral part of Q'URM, the Queen's University Urban Runoff Model. It has been developed and calibrated on the basis of data from a stormwater quality sampling program on the Calvin Park basin in Kingston, Ontario, and verified on the basis of data from an independent study of runoff quality in the Malvern basin in Burlington, Ontario. (Author's abstract)
W90-04022

ENVIRONMENTAL AND ECONOMIC IMPLICATIONS OF RISING SEA LEVEL AND SUBSIDING DELTAS: THE NILE AND BENGAL EXAMPLES.
Woods Hole Oceanographic Institution, MA. Dept. of Geology and Geophysics.
J. D. Milliman, J. M. Broadus, and F. Gable.
AMBIO AMBOCX, Vol. 18, No. 6, p 340-345, 1989. 4 fig, 1 tab, 52 ref.

Descriptors: *Deltas, *Subsidence, *Egypt, *Bangladesh, *Nile River, Sediment transport, Sediment distribution, Sedimentation rates, Erosion, Bengal River.

The effects of natural and accelerated subsidence, combined with a probable decreased influx of fluvial sediment, may accentuate greatly the rise of sea level in low-lying deltas over the next 100 years. By the year 2100, local sea level at the Nile and Bangladesh deltas could be as much as 3.3 to 4.5 meters higher than at present. At the higher calculated ranges, Egypt could lose 26% and Bangladesh could lose 34% of their currently habitable land. The additional loss of shoreline by erosion, loss of mangrove forests, and decreased agriculture and fisheries would exacerbate environmental and economic impacts. Although many problems are perceived, no clear and noncontroversial answers are apparent. Environmental parameters, however, should be documented prior to diversion and damming of rivers or increased groundwater removal. The environmental and economic effects of these sea-level scenarios are sufficiently grave to warrant their consideration in future coastal and fluvial planning, not only in Egypt and Bangladesh, but also in other areas with low-lying deltas and large rivers. Most such areas occur in southern Asia, which contributes more than 70% of the fluvial sediment reaching the ocean. (Author's abstract)
W90-04083

PREDICTION OF SEDIMENT SAMPLING ERROR AT NOZZLE.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 7B.
W90-04126

COMPARISON: US P-61 AND DELFT SEDIMENT SAMPLERS.
Geological Survey, Minneapolis, MN.
J. P. Beverage, and D. T. Williams.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1702-1706, December 1989. 5 fig, 4 ref.

Descriptors: *Sediment sampler, *Suspended sediments, *Sediment transport, *Samplers, *Sand, *Streams, Mississippi River, Colorado River, Error analysis, Comparison studies.

The Delft Bottle (DB) is a flow-through device designed by the Delft Hydraulic Laboratory to sample sand-sized sediment suspended in streams. The US P-61 sampler was designed by the Federal Interagency Sedimentation Project to collect suspended sediment from deep, swift rivers. A comparison of these two samplers was undertaken on the Mississippi and Colorado Rivers. The studies compared sand transport rates, rather than total sediment transport, because fine material washes through the DB sampler. Results showed that the P-61 sampler collects a true sample--a representative aliquot of the water-sediment mixture passing through the nozzle during the sampling interval. The sampling interval is short relative to that of the DB, and samples often show the short-term variability typical of sediment-laden streams. The DB collects most of the coarse sediment (>0.100 mm) during a much longer interval, which averages out short-term variations. Strictly speaking, the DB does not collect a sample. The collected sediment mass must be corrected for various factors, but principally stream velocity. The DB is essentially a large expansion chamber providing a low-velocity region for deposition of sediments coarser than 0.100 mm. At high velocities, larger sediments are flushed through the device. Sampling at velocities >2.5 m/s is not recommended. The P-61 collects isokinetically the entire mass of water and sediment entering the nozzle. It is more than twice the weight of the DB and thus needs more rugged handling equipment, but it is more stable than the DB in fast water. The P-61 has a valve and solenoid that occasionally require servicing. The DB, on the other hand, has no valve. A large amount of sediment can be collected (because the water is not retained), which allows a quick volumetric estimation of the coarse sediment mass. The conversion from volume to mass can add further error to those inherent in sampling nonisokinetically. (Sand-PTT)
W90-04127

GEOMORPHIC EFFECTS OF TWO STORMS ON THE UPPER WAITAHAIA RIVER CATCHMENT, RAUKUMARA PENINSULA, NEW ZEALAND.
New Zealand Forest Service, Rotorua. Forest Research Inst.
C. J. Phillips.
Journal of Hydrology (New Zealand) JLHYAD, Vol. 27, No. 2, p 99-112, 1988. 7 fig, 3 tab, 32 ref.

Descriptors: *Geomorphology, *Floods, *Storm runoff, *New Zealand, *Rainstorms, *Catchment areas, *Landslides, *Erosion, *Stream erosion, *Mass transport, *Aggradation, *Floods, Geology, Waitahaia River, Raukumara Peninsula.

Geomorphic response of a drainage basin to two large storms was assessed by river cross-sectional surveys and landslide inventories. Rainfall intensities of 80-150 mm/hour over 3 days in December 1980 caused widespread landsliding and subsequent stream aggradation. Most landslides were small (<100 cu m) and most occurred on steep slopes (35 degrees). Stream aggradation varied from 2.7 m to 5 m. By 1985, stream downcutting had not restored pre-storm 1980 levels. A shorter duration, less-intense rainstorm in April 1982 caused only minor landsliding. Sediment storage and transfer appear to be related to a cyclic process that moved material from one storage locality to the next. Geomorphic effectiveness of the two storms can be related to crossing of slope thresholds in the first storm but not in the second. (Author's abstract)
W90-04131

PHYSICAL HYDRAULIC MODELLING OF WIDTH REDUCTION AND BED LEVEL CHANGE IN BRAIDED RIVERS.
Lincoln Coll., Canterbury (New Zealand). Dept. of Natural Resource Engineering.
T. R. Davies, and A. L. Lee.
Journal of Hydrology (New Zealand) JLHYAD, Vol. 27, No. 2, p 113-127, 1988. 9 fig, 20 ref.

Descriptors: *Sediment transport, *Channel morphology, *Braided streams, *Hydraulic models, *Streambeds, *River beds, *Turbulent flow, *Bed load, *Aggradation, *Stream degradation, Sediment load.

To study the effect of width reduction on the rate of change of mean bed level of a braided river, a characteristic Froude law rough-turbulent flow hydraulic model of a medium-sized braided river was developed. This was then subjected to imposed width reductions to as little as 35% of its unconstrained width, under various sediment input regimes. The response of the model was complicated, but all width reductions increased the bedload transport capacity of the river; whether or not this caused the rate of aggradation (bed level rise) to increase depended on the sediment input rate. At high sediment input rates, width reduction increased the aggradation rate, whereas at low input

rates the reverse occurred. Hence, width reduction alone is not a suitable means of controlling aggradation in a braided river; in some cases, troublesome degradation could be thus induced. Bed width reduction alone cannot cause aggradation where none was originally present. (Author's abstract)
W90-04132

PROGRAM TO CALCULATE CHANNEL SCOUR AND FILL.
Pacific Northwest Forest and Range Experiment Station, Juneau, AK. Forestry Sciences Lab.
J. R. Noel, and R. C. Sidle.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 733-741, August 1989. 2 fig, append, 11 ref.

Descriptors: *Computer programs, *Sediment transport, *Channel scour, *Computer models, *Stream erosion, BASIC, Water depth, Stream profiles.

A computer program written in BASIC calculates net changes in stream channel cross-sections. Calculations are based on dividing the channel cross-section into discrete regions of scour and fill. Internal boundaries of these regions (along the x-axis of the cross-section) are determined by the location of vertical depth measurements taken at two distinct times. The right and left boundaries of the cross-section can be specified so that scour or fill can be calculated for any portion of the profile desired. The user can modify the program by setting up files to accommodate multiple cross sections on several streams. A complete listing of the program is included. (Author's abstract)
W90-04169

EFFECTS OF SIMULATED CANOPY COVER AND ANIMAL DISTURBANCES ON RILL AND INTERRILL EROSION.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
M. R. Savabi, and G. F. Gifford.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 783-788, August 1989. 7 fig, 2 tab, 16 ref.

Descriptors: *Model studies, *Land use, *Soil erosion, *Rill erosion, *Erosion control, Canopy, Simulation studies, Clays, Loam, Sand, Trampling, Depressions.

A rainfall simulator was used on runoff plots to study the effects of simulated canopy cover, trampling disturbance, and soil type on rill and interrill erosion. Sandy loam soil was more erodible than clay loam soil. Furthermore, the simulated canopy cover significantly influenced rill and interrill erosion. The effect of trampling on rill and interrill erosion varied with soil type (clay loam versus sandy loam) and erosion type (rill versus interrill erosion). On large plots, where both rill and interrill erosions were involved, 30 percent trampling significantly increased soil loss. However, on small plots, 30% trampling significantly reduced interrill erosion. The results of the study support the following conclusions: (1) canopy cover significantly reduced the soil loss on sandy loam and clay loam soils; (2) under similar conditions (canopy cover, trampling, and soil moisture), sandy loam soil is more susceptible to rill-interrill erosion than clay loam soil; (3) soil detachment by concentrated flow (rilling) is a significant portion of the total erosion (rill and interrill) on large plots containing sandy loam soils; and (4) the effect of an increase in water storage in depressions on the soil surface hoof prints on soil erosion depends on rilling processes. If rill erosion is involved, increased depression storage should increase rill erosion. Where rill erosion is absent, increased depression storage will reduce interrill erosion. (Author's abstract)
W90-04175

FLUVIAL SEDIMENT STORAGE IN WETLANDS.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
J. D. Phillips.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 867-873, August 1989. 1 tab, 35 ref.

Descriptors: *Geomorphology, *Sediment transport, *Wetlands, *Sediment distribution, *River sediments, River basins, Fluvial sediments, Watershed management, Alluvial deposits.

The important ecological and hydrological roles of wetlands are widely recognized but the geomorphic functions of wetlands are also critical. Wetlands can be defined in geomorphic, as well as in hydrological or biological terms, and a geomorphic definition of wetlands has been proposed. An analysis of fluvial sediment budget studies shows that wetlands typically serve as short-term sediment sinks or longer-term sediment storage sites. In ten study basins of various sizes, an estimated 14 to 58 percent of the total upland sediment production is stored in alluvial wetland or other aquatic environments. Of the sediment reaching streams, 29 to 93 percent is stored in alluvial wetland or channel environments. For basins of more than 100 sq km, more than 15% of total upland sediment production and more than 50% of sediment reaching streams is deposited in wetlands. The data underestimates the magnitude of wetland sediment storage due to the lack of data from large river systems. A theoretical analysis of river channel sediment delivery shows that wetland and aquatic sediment storage is inevitable in fluvial systems and systemically related to basin size. Results suggest that wetlands should be managed in the context of drainage basins, rather than as discrete, independent units. (Author's abstract)
W90-04184

ANALYSIS OF THEMATIC MAPPER DATA FOR STUDYING THE SUSPENDED MATTER DISTRIBUTION IN THE COASTAL AREA OF THE GERMAN BIGHT (NORTH SEA).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
R. Doerffer, J. Fischer, M. Stossel, C. Brockmann, and H. Grassl.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 61-73, April/June 1989. 10 fig, 2 tab, 12 ref. NASA Contract A.O.NO.OSSA-3-84.

Descriptors: *Landsat Thematic Mapper, *Remote sensing, *Suspended solids, *North Sea, *Satellite technology, Temperature, Atmospheric scattering, Model studies, Data processing, Correlation analysis.

Thematic Mapper data were analyzed with respect to their capability for mapping the complex structure and dynamics of suspended matter distribution in the coastal area of the German Bight (North Sea). Three independent pieces of information were found by factor analysis of all seven TM channels: suspended matter concentration, atmospheric scattering, and sea surface temperature. For the required atmospheric correction the signal to noise ratios of Channels 5 and 7 have to be improved by averaging over 25x25 pixels, which allows the monitoring of aerosol optical depth and aerosol type over cloud-free water surfaces. Near surface suspended matter concentrations may be detected with an accuracy of factor <2 by using an algorithm derived from radiative transfer model calculations. The patchiness of suspended matter and its relation to underwater topography was analyzed with auto-correlation and cross-correlation. Horizontal lengths, where the suspended matter concentration of single pixels, are significantly correlated either with each other or with water depth are in the order of 1 km. (Author's abstract)
W90-04193

MONITORING SEDIMENT TRANSPORT SYSTEMS IN A SEMIARID AREA USING THEMATIC MAPPER DATA.
Reading Univ. (England). Dept. of Geography.
N. A. Quarmby, J. R. G. Townshend, A. C. Millington, K. White, and A. J. Reading.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 305-315, April/June 1989. 6 fig, 1 tab, 17 ref. National Environment Research Council Contract No. F60/G6/12.

Descriptors: *Remote sensing, *Satellite technology, *Sediment transport, *Mapping, *Tunisia, *Landsat Thematic Mapper, Groundwater, Geomorphology, Fluvial transport.

Thematic Mapper data, in the form of false color composites and change detection images, have been used to monitor and map four geomorphological process domains in southern Tunisia over a 4-year period. Hillslope, river channel, alluvial fan, and salt lake environments were examined using field surveys, laboratory analysis of sediment samples, and remotely sensed data. An assessment is made of the utility of Thematic Mapper data for geomorphological monitoring of these environments. The detection of large fluvial channels and circular ground water features (aioun) within one large playa have shown the value of using remotely sensed imagery for geomorphological mapping in such environments. As a result of this research it is shown that the traditional model of salt lake development based on the relative solubility of salts may need to be modified to take into account the influence of fluvial transport. Monitoring geomorphological changes in other process domains provided less satisfactory results; largely it is believed because of the almost complete absence of major rainfall events during the study period; however, geomorphological changes due to anthropogenic activity were successfully monitored. (Author's abstract)
W90-04196

COARSE WOODY DEBRIS AND CHANNEL MORPHOLOGY: A FLUME STUDY.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
For primary bibliographic entry see Field 8I.
W90-04207

ENVIRONMENTAL INFORMATION FROM SEDIMENTS.
Geological Survey, Menlo Park, CA. Geologic Div.
For primary bibliographic entry see Field 6G.
W90-04321

GEOMORPHIC EVIDENCE OF FREQUENT AND EXTREME FLOODS.
Wisconsin Univ.-Madison. Dept. of Geography.
J. C. Knox.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 220-238, 9 fig, 39 ref.

Descriptors: *Geomorphology, *Flood frequency, *Bed load, *Alluvial channels, Flood plain sediments, Historic floods, Flood flow, Flood channels, Mathematical studies, Flood forecasting.

Geomorphic properties of alluvial channels and floodplains offer an important supplementary source of information on magnitude and frequency characteristics of floods. The morphologic dimensions of alluvial channels have strong statistical correlations with low magnitude, high frequency floods. The strong relationship can be exploited to estimate magnitudes of high frequency floods in regions where river gaging data do not exist. Because the morphology of alluvial channels in most regions is shaped by floods which tend to recur frequently, channel morphology has limited usefulness in estimating potential magnitudes of extremely large and infrequent floods. Magnitudes of potential extreme floods are best estimated from the physical properties of alluvial deposits that are related to former extreme floods. Especially useful in the reconstruction of former depths of large floods is the relationship between stream competency, as measured by the DuBoys equation, and the size of the largest bedload particles transported during floods. Because extreme floods frequently result in the burial of datable materials (radiocarbon, archaeological etc.), it also is often possible to date their approximate time of occurrence. Because the time span associated with alluvial sediments under investigations may spread over hundreds of years, or even a few thousand years, the

dated flood events provide an important understanding of the recurrence intervals of large and extreme floods. These methods also greatly assist in the determination of the true recurrence interval of an unusually extreme flood that may be contained in a short record associated with a period of stream gaging. As with most techniques and methodologies for estimation of flood characteristics, there are many assumptions and conditions associated with the use of the geomorphic methods. Wherever possible, results from geomorphic methods should be cross-checked against results from other methods. (See also W90-04308)(Lantz-PTT)
W90-04322

SOIL EROSION CONTROL: WATERWAY EMBANKMENTS. NOVEMBER 1986-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 4D.
W90-04479

2K. Chemical Processes

GEOCHEMISTRY OF THERMAL WATER FROM SELECTED WELLS, BOISE, IDAHO.
Geological Survey, Menlo Park, CA.
R. H. Mariner, H. W. Young, D. J. Parliman, and W. C. Evans.
IN: Geothermal Resources Council, TRANSACTIONS, Vol. 13, pp 173-178, October 1989. 5 fig, 4 tab, 11 ref.

Descriptors: *Idaho, *Geothermal water, *Geochemistry, *Thermal water, *Groundwater quality, Wells, Boise, Chemical analysis, Radioactivity, Groundwater recharge, Geothermal water, Paleohydrology, Deuterium, Oxygen radioisotopes.

Samples of thermal water from selected wells in the Boise area were analyzed for chemical composition; stable isotopes of hydrogen, oxygen, and dissolved carbon; radioactive carbon; and dissolved gas concentrations. Chemically, the waters are virtually identical to those of the adjacent Idaho batholith. Isotopically, the thermal waters are more depleted in deuterium and oxygen-18 than cold water springs in the presumed recharge area. Chemical and geothermal isotopic data indicate the presence of two separate geothermal systems. Radioactive carbon and dissolved helium concentrations are interpreted to indicate recharge during the Pleistocene. Hot water in or southeast of Boise probably recharged 20,000 to 30,000 years ago, and warm water 2.5 miles northwest of Boise probably recharged at least 15,000 years ago. Recharge to the system during the Pleistocene would have been more depleted in deuterium and oxygen-18 than modern precipitation because of the colder climate during the Pleistocene. (Author's abstract)
W90-03820

IN SITU MEASUREMENTS OF TOTAL REACTIVE NITROGEN, TOTAL WATER, AND AEROSOL IN A POLAR STRATOSPHERIC CLOUD IN THE ANTARCTIC.
National Oceanic and Atmospheric Administration, Boulder, CO. Aeronomy Lab.
For primary bibliographic entry see Field 2B.
W90-03901

GROUNDWATER CHEMISTRY AND PALAEORECHARGE IN THE AMADEUS BASIN, CENTRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia). Div. of Continental Geology.
For primary bibliographic entry see Field 2F.
W90-03905

GROUNDWATER'S DYANAMIC ROLE IN REGULATING ACIDITY AND CHEMISTRY IN A PRECIPITATION-DOMINATED LAKE.
Wright State Univ., Dayton, OH. Dept. of Geological Science.
For primary bibliographic entry see Field 2H.
W90-03907

HYDROCHEMICAL BUDGETS FOR THE LOCH DEE EXPERIMENTAL CATCHMENTS, SOUTHWEST SCOTLAND (1981-1985).
Saint Andrews Univ. (Scotland). Dept. of Geography and Geology.
D. A. Farley, and A. Werritty.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 351-368, August 1989. 2 fig, 10 tab, 28 ref.

Descriptors: *Experimental basins, *Geochemistry, *Acid rain effects, *Solute transport, *Catchment areas, *Rainfall-runoff relationships, *Lakes, *Reforestation, *Scotland, Potassium, Sodium, Aluminum, Phosphates, Calcium, Magnesium, Silica, Spatial distribution, Heavy metals.

Spatial variations in the hydrochemical budgets of the study sub-catchments at Loch Dee are related to differences in the underlying geology and land-use management practices. The influence of afforestation is difficult to judge as the plantations are less than 15 years old. Pre-afforestation plowing in the Green Burn served to increase the output of acidity and aluminum during high flows and the output of base cations and silica during low flows. However, the Green burn is less inimical to fish populations than the equally-acidic Dargall Lane Burn, suggesting that more of the aluminum in the Green Burn is in an organic form. The White Laggan Burn, where catchment and forestry management techniques have been applied, has both acidity and aluminum levels far lower than those in the neighboring catchments. However, the influence of the limestone inputs is hard to separate from the contrasts in underlying geology, and the hardwoods of the buffer zone are still too immature to be of significance. Consequently, the impact of the amelioration techniques on the water quality of the White Laggan Burn is likely to be less than that of the presence of the unmetamorphosed sediments in the headwaters. Temporal variations in catchment losses of bases and nutrients can generally be related to the amount of precipitation , possibly indicating a greater flow through the lower mineral soil in wetter years. In contrast, sulfate losses tend to vary independently of precipitation, thereby supporting the view that the dry deposition of sulfate and attendant inputs of acidity vary considerably from year to year. (Friedmann-PTT)
W90-03911

USE OF A NOVEL ACETONE-H2O2-CLO(-) CHEMILUMINESCENCE SYSTEM FOR THE DETERMINATION OF IODIDE ION.
University of Science and Technology of China, Hefei. Dept. of Applied Chemistry.
For primary bibliographic entry see Field 7B.
W90-03920

ABSORPTION OF SULFUR DIOXIDE ON MONODISPERSE WATER DROPLETS AND CATALYTIC ACTIVITY OF CARBON PARTICLES.
Istituto FISBAT-CNR, Bologna, Italy.
For primary bibliographic entry see Field 5B.
W90-03933

ORIGIN OF THE CHEMICAL COMPOSITION OF RUNOFF WATERS IN A TROPICAL RAIN ZONE: STUDY OF TWO SMALL FORESTED WATERSHEDS IN FRENCH GUYANA (ORIGINE DE LA COMPOSTION CHIMIQUE DES EAUX SUPERFICIELLES EN MILIEU TROPICAL HUMIDE: EXEMPLE DE DEUX PETITS BASSINS VERSANTS SOUS FORET EN GUYANE FRANCAISE).
Office de la Recherche Scientifique et Technique Outre-Mer, Cayenne (French Guiana).
C. Grimaldi.
Sciences Geologiques (Bulletin) BIGPA8, Vol. 41, No. 3-4, p 247-262, 1988. 11 fig, 1 tab, 21 ref. English summary.

Descriptors: *Forest watersheds, *Rain forests, *Runoff, *Water chemistry, *Soil properties, *Geochemistry, Hydrologic cycle, Evapotranspiration, Forest hydrology, Groundwater, Tropical regions, Water analysis, Aluminum, Silicates, Sulfates, Nitrates, Chlorides.

A study of the chemical composition of the runoff water during rain episodes was conducted in French Guyana. A comparison of this composition with that of groundwater indicated three types of behavior for the following groups of elements or compounds: (1) K(+), Ca(2+), NO3(-), and SO4(2-) play a very important role in the vegetation biochemical cycle; (2) Na(+), Mg(2+), and especially Cl(-), whose concentrations are excessive compared to the requirements of the vegetation and reveal the intensity of the evapotranspiration acting on the soil solution; and (3) Al and H4SiO4, mostly of inorganic origin, which displayed an important surface chemical erosion with simultaneous loss of these two elements, while at depth, Al is mostly immobile. The pH of these natural waters depends on ionic exchanges with the vegetation and also on the production of organic acids resulting from the decomposition of forest litter. Variations in the pH are very rapid because of the absorption power of the soil and the weakness of the solutions. The pH was generally < 5 because of the organic acids in the surface water; it decreased to 4.5 in the groundwater. Research on newly formed mineral phases susceptible of controlling the concentration of Al and silicates in solution did not correspond satisfactorily to diagrams of thermodynamic equilibrium. Additional information should be obtained to permit an intelligent discussion of the deviations observed from the theory. However, these results represent a stage in the study of the geochemical functions of soils in the region. (Peters-PTT)
W90-03951

COMPARATIVE HYDROCHEMICAL BUDGETS AND WEATHERING AND ACIDIFICATION RATES IN THREE SMALL SIMILAR GRANITIC WATERSHEDS WITH CONTRASTED VEGETATION (MONT LOZERE, FRANCE) (COMPARAISON DES BILANS HYDROCHIMIQUES, DES TAUX D'ALTERATION ET D'ACIDIFICATION DANS TROIS PETITS BASSINS VERSANTS GRANITIQUES SIMILAIRES A VEGETATION CONTRASTEE (MONT LOZERE, FRANCE)).
Orleans Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 5B.
W90-03952

EFFECTS OF ALKALINITY ON THE REACTIVITY OF OZONE TOWARDS HUMIC SUBSTANCES AND MANGANESE.
Omnium de Traitement et Valorisation, Maisons-Laffitte (France). Chemin de la Digue.
For primary bibliographic entry see Field 5F.
W90-03962

REACTIONS OF OZONE WITH D-GLUCOSE IN OXYGENATED AQUEOUS SOLUTION: DIRECT ACTION AND HYDROXYL RADICAL PATHWAY.
Max-Planck-Inst. fuer Strahlenchemie, Muelheim an der Ruhr (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W90-03973

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: III. POLY(ACRYLIC ACID) AND SUBSTITUTED POLY(ACRYLIC ACID) HOMO, CO, AND TERPOLYMER MEMBRANES.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
For primary bibliographic entry see Field 3A.
W90-03993

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: IV. MALEIC ANHYDRIDE COPOLYMERS.

Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
For primary bibliographic entry see Field 3A.
W90-03994

DYNAMIC PARTICLE ADHESION PROCESS AND ITS EFFECT ON PARTICLE AGGREGATION.
Rheinisch-Westfaelische Wasserwerksgesellschaft m.b.H., Muelheim an der Ruhr (Germany, F.R.). Inst. fuer Wasserchemie und Wassertechnologie.
R. Gimbel.
Aqua AQUAAA, Vol. 38, No. 3, p 156-164, April 1989. 10 fig, 15 ref.

Descriptors: *Aggregation, *Particulate matter, *Hydrodynamics, *Water treatment, *Coagulation, *Wastewater treatment, Substrates, Interfaces, Particle shape, Filtration, Flocculation, Structure, Physicochemical properties, Kinetics, Mathematical models, Adhesion.

Particle adhesion in aqueous systems is treated on the basis of different surface-interaction and hydrodynamic forces. The adhesion is an extension of the DLVO theory and has to be considered as a dynamic process, which depends strongly on the surface structure of the solids, e.g. the size and deformation behavior of roughnesses. The dynamic adhesion process with several particle-plate model systems was investigated. Time dependence of the net adhesion force in quasi-static systems is included and the adhesion behavior of micron particles is analyzed in a shear flow field using high frequency microkinematography. A strong influence of Ca(++) ions and adsorbed macromolecules is shown. Observed effects are discussed on the basis of a microscopic description of dynamic adhesion behavior in aggregating systems. (VerNooy-PTT)
W90-04013

EFFECT OF BROMIDE IONS ON TRIHALOMETHANE (THM) FORMATION IN WATER.
Institute of Public Health, Tokyo (Japan). Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 5F.
W90-04014

IONSPRAY MASS SPECTROMETRY/MASS SPECTROMETRY: QUANTITATION OF TRIBUTYLTIN IN A SEDIMENT REFERENCE MATERIAL FOR TRACE METALS.
National Research Council of Canada, Ottawa (Ontario). Div. of Chemistry.
For primary bibliographic entry see Field 5A.
W90-04037

ACID-SENSITIVE WATERS OF THE ENGLISH LAKE DISTRICT: A STEADY-STATE MODEL OF STREAMWATER CHEMISTRY IN THE UPPER DUDDON CATCHMENT.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 5B.
W90-04042

HYDROGEN PEROXIDE CONCENTRATION IN A NORTHERN LAKE: PHOTOCHEMICAL FORMATION AND DIEL VARIABILITY.
Florida International Univ., Miami. Drinking Water Research Center.
For primary bibliographic entry see Field 5B.
W90-04052

DISTRIBUTION OF COLLOIDAL ALUMINUM AND ORGANIC CARBON IN COASTAL AND OPEN OCEAN WATERS OFF NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W90-04053

RARE EARTH ELEMENTS IN SAANICH INLET, BRITISH COLUMBIA, A SEASONALLY ANOXIC BASIN.
Cambridge Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2H.
W90-04055

DETERMINATION OF MERCURY IN ENVIRONMENTAL SAMPLES BY COLD VAPOUR GENERATION AND ATOMIC-ABSORPTION SPECTROMETRY WITH A GOLD-COATED GRAPHITE FURNACE.
Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea).
For primary bibliographic entry see Field 5A.
W90-04067

CORRECTNESS TEST OF THE COMPUTATION OF CHEMICAL SPECIATION FOR THE MAIN CONSTITUENTS OF NATURAL WATERS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Radiochemie.
S. H. Eberle.
Water Research WATRAG, Vol. 23, No. 11, p 1373-1382, November 1989. 4 fig, 3 tab, 35 ref, 2 append.

Descriptors: *Water analysis, *Chemical analysis, *Chemical speciation, *Conductivity, *Hydrogen ion concentration, Comparison studies, Model studies, Equilibrium constants, Chemical complexes.

The agreement between measurement and a speciation model-based computation of the pH and the electrolytic conductivity was investigated for the three test cases: standard buffers, artificial model waters and routine laboratory reports of water analysis. The standard deviation for the differences between experimental and computed pH was found to be delta-pH < or = 0.04 and for the electrolytic conductivity the analogous difference is less than 1%. This result was obtained considering complexes and using the extended Debye-Huckel equation for the activity coefficient; however, other equations are not substantially worse. The constituents of the species system tested are the hydrogen ion, hydroxyl ion, sodium, potassium, calcium, magnesium, ammonia, carbonate, sulfate, chloride, nitrate, phosphate, borate and silicate. A set of equilibrium constants and their temperature dependency factors is presented. (Author's abstract)
W90-04144

GEOCHEMICAL VARIATIONS IN A CORE OF HYDROGEOLOGIC UNITS NEAR FREEHOLD, NEW JERSEY.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-04159

DETECTING BIOTIC AND HYDROGEOCHEMICAL PROCESSES IN LARGE PEAT BASINS WITH LANDSAT TM IMAGERY.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 7B.
W90-04195

KINETICS OF ENDOGENOUS DECAY, DEATH, AND LYSIS FOR VIABLE ORGANIC SOLIDS.
Arizona Univ., Tucson.
For primary bibliographic entry see Field 5D.
W90-04261

NATURAL FLUCTUATIONS OF WATER QUALITY IN A HEADWATER STREAM.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
For primary bibliographic entry see Field 4C.
W90-04336

CHANGES IN METAL MOBILITIES IN AQUATIC AND TERRESTRIAL CYCLES.
Technische Univ. Hamburg-Harburg (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-04371

GENERAL AFFINITY CONCEPTS, EQUILIBRIA AND KINETICS IN AQUEOUS METALS CHEMISTRY.
California Inst. of Tech., Pasadena.
For primary bibliographic entry see Field 5B.
W90-04372

CURRENT STATUS OF METAL SPECIATION STUDIES.
Quebec Univ., Sainte-Foy.
P. G. C. Campbell, and A. Tessier.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 201-224, 7 tab, 94 ref.

Descriptors: *Metals, *Speciation, *Particulate matter, *Dissolved solids, *Separation techniques, *Chemical analysis, *Path of pollutants, Model studies, Molecular structure, Trace metals, Sediments, Literature review.

Metal species exist in water along a size spectrum ranging from dissolved through colloidal to particulate phases. Both dissolved and particulate metal species are considered. Current modeling and experimental approaches to metal speciation in solution are imperfect, yet complementary. Since in both a geochemical and a toxicological context the preeminent metal species is the aquo ion, and since the modeling approach is most reliable for inorganic systems, one of the goals of the experimental approach should be to provided a clean separation between inorganic and organic forms. The estimate for the sum of the inorganic metal forms can then serve as input to an equilibrium speciation model. Metal partitioning as determined by sequential extraction procedures may be influenced by such factors as the choice of reagents used for the various extraction steps, the extraction sequence, the contact time between the particulate material and the extractant, and the solid:extractant ratio. Although sequential extraction procedures are inherently selective, tests to date suggest that selectivity is reasonably satisfactory for low-sulfide (oxic) sediments. For sulfide-rich (anoxic) sediments, however, several lines of evidence indicate that the various extraction procedures currently in use in the environmental field are compromised by the tendency of the metal-containing sulfide phases to be leached progressively rather than selectively from the host sediment. (See also W90-04370) (VerNooy-PTT)
W90-04377

DECOMPOSITION IN WASTEWATER WETLANDS.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
For primary bibliographic entry see Field 5D.
W90-04431

DENITRIFICATION IN ARTIFICIAL WETLANDS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Biotechnologie.
For primary bibliographic entry see Field 5D.
W90-04434

NITROGEN REMOVAL FROM FRESHWATER WETLANDS: NITRIFICATION-DENITRIFICATION COUPLING POTENTIAL.
Florida Agricultural and Mechanical Univ., Tallahassee. Wetland Ecology Program.
For primary bibliographic entry see Field 5D.
W90-04435

MANGANESE AND IRON ENCRUSTATION ON GREEN ALGAE LIVING IN ACID MINE DRAINAGE.
Memphis State Univ., TN. Dept. of Biology.
For primary bibliographic entry see Field 5D.

W90-04470

2L. Estuaries

ECOLOGICAL STUDIES IN THE MIDDLE REACH OF CHESAPEAKE BAY: CALVERT CLIFFS.
For primary bibliographic entry see Field 4C.
W90-03599

GENERAL CHARACTERISTICS OF THE CHESAPEAKE BAY AND STUDY AREA.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
K. G. Sellner, and B. A. Peters.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 1-10, 11 fig, 48 ref.

Descriptors: *Environmental effects, *Estuarine environment, *Estuarine fisheries, *Estuaries, *Chesapeake Bay, *Suspended sediments, *Water circulation, *Nuclear powerplants, *Thermal pollution, Heated water, Water temperature, Plumes, Calvert Cliffs Nuclear Power Plant, Bays, Saline-freshwater interfaces, Mixing, Tidal currents, Commercial fishing, Sport fishing, Shellfish, Fish.

Chesapeake Bay has an average depth of 9 m and receives the majority of its fresh water, sediments and nutrients from the Susquehanna River. Circulation in Chesapeake Bay is typical of partially mixed estuaries with nontidal and tidal components producing a net seaward-moving fresh surface layer and a landward-moving saline bottom layer. As a result, particle concentrations (i.e., turbidity, total suspended solids) have a distinct longitudinal distribution in the Bay with freshwater regions characterized by moderate suspended loads, a transition zone (maximum turbidity zone) where particle concentrations increase dramatically, and more seaward areas with water columns relatively free of suspended particles. The area of the Chesapeake Bay adjacent to Calvert Cliffs is commercially fished for oysters and blue crabs. Finfish in the area of commercial and recreational importance include striped bass, spot, weakfish, bluefish, and summer flounder. The Calvert Cliffs Nuclear Power Plant (CCNPP) is located within the study area. Circulation through the plant affects local circulation patterns in the area. Power plant-related changes in local hydrographic and chemical properties are governed by the dispersion of the CCNPP effluent. The thermal plume produced from plant operations at Calvert Cliffs generally floats, but its size, shape and depth vary with season, tidal stage, meteorological conditions, operating conditions, and plant load. The plume results in slightly higher water temperatures in the vicinity of the plant. Highest excess temperatures occur at the shallow shoals immediately north of the plant during and immediately following flooding tide. With one unit operating, the bottom area covered by temperatures > 1 C above ambient is between 0 and 63 hectares; with two units operating, the area of the bottom covered by water > 1 C or more above ambient temperatures was generally no greater than 75 hectares (See also W89-03599) (Lantz-PTT)
W90-03600

PHYTOPLANKTON: RELATIONSHIPS BETWEEN PHYTOPLANKTON, NUTRIENTS, OXYGEN FLUX AND SECONDARY PRODUCERS.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
K. G. Sellner, and M. E. Kachur.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 12-37, 9 fig, 3 tab, 7 ref.

Descriptors: *Oxygen transfer, *Secondary productivity, *Phytoplankton, *Chesapeake Bay, *Species composition, Seasonal variation, Biological studies, Primary productivity, Nutrients, Ecosystems, Nitrogen, Silicates, Phosphorus, Species diversity, Population dynamics.

In an intensive multi-component 8-yr study (1974-1981) of mesohaline waters along the shallow western shore of Chesapeake Bay, phytoplankton species composition, productivity and pigment concentrations were routinely determined in monthly sample collections. In general, small, flagellated cells dominated total cell densities in the summer months while centric diatoms dominated assemblages in the winter, spring and fall. Highest phytoplankton densities, > or = 53,000,000 cells/L, were observed in the spring bloom in bottom waters. Highest chlorophyll concentrations were observed during peaks of biomass-dominant cells, i.e., diatoms or dinoflagellates, rather than during periods of nanoflagellate dominance. Primary productivity was highest in the summer, ranging from 1.37 to 2.75 gC/sq m/day and generally coincided with high dinoflagellate densities. Annual rates ranged from 167 to 392 gC/sq m. Nutrient concentrations and elemental ratios suggest occasional nutrient limitation of phytoplankton production in the region, with a limited phosphorus data set suggesting P-limitation in spring. Nitrogen limitation was possible in approximately one-half of the summer and early fall months sampled (13 to 24). However, regenerated nitrogen could supply rapid and frequent pulses of dissolved inorganic nitrogen throughout the summer and fall. A significant inverse relationship, observed between changes in silicate concentrations and fluctuations in diatom densities throughout the study period, suggests that silicate limitation may occasionally lead to the collapse of the spring bloom in mesohaline waters of Chesapeake Bay. Grazing by macrozooplankton (> 73 micrometers) removed 17 to 83% of phytoplankton standing stock during the late summer (July-September) of each year with < or = 15% removed by planktonic herbivores throughout the rest of the year. (See also W90-03599) (Author's abstract)
W90-03601

ZOOPLANKTON.
Computer Services Corp., Annapolis, MD.
M. M. Olson.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 38-81, 11 fig, 8 tab, 30 ref.

Descriptors: *Ecological effects, *Zooplankton, *Seasonal variation, *Chesapeake Bay, *Species composition, *Nuclear powerplants, Copepods, Barnacles, Regression analysis, Polychaetes, Shellfish, Population density, Distribution patterns, Thermal pollution, Water pollution effects, Water temperature.

Zooplankton data collected between 1975 and 1980 near Calvert Cliffs Nuclear Power Plant provided information about the species composition over each annual cycle, about the nature and extent of temporal and spatial population variations, and provided the basis for an exploration of biological and environmental relationships using linear regression techniques. Adult and juvenile copepods were the major numerical constituents in the pumped sample collections, followed by naupliar and cyprid stage barnacles, polychaete larvae, a marine cladoceran, clam and other bivalve larvae, rotifers, and zoeal mud crabs. Weekly studies and 24-hr and 48-hr time series studies showed that zooplankton abundance varied substantially over these relatively short time spans. Some species exhibited a range of abundance over 24-hr that was as large as observed over the annual cycle, and vertical and horizontal distributions of zooplankton could be equally as variable. Data from the time series studies illustrate this point. The station and depth distributions of the zooplankton near Calvert Cliffs were originally analyzed in the context of the powerplant there and its effects on zooplankton spatial distributions. The zooplankton near Calvert Cliffs attained maximum densities in the summer between July and September, with annual maxima ranging between 30,000/cu m in 1976 and 135,000/cu m in 1980. Relationships between the abundance of the copepod Acartia tonsa and concurrently monitored environmental and biologic variables were explored using stepwise multiple regression techniques. The independent variables were chosen from water quality, food, and predator abundance parameters monitored in the studies. Because Acartia density is correlated with temperature, and is reproductively dormant over the winter, the regression models were developed using only data from the months of May through October each year. In two of the five years, 1977 and 1980, temperature was the only significant variable. Yet, in 1978 and 1979, the models included biological parameters, and temperature did not even enter the models. (See also W89-03599) (Lantz-PTT)
W90-03602

EPIFAUNA.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
G. R. Abbe.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 82-96, 6 fig, 3 tab, 13 ref.

Descriptors: *Marine animals, *Estuarine environment, *Nuclear powerplants, *Ecological effects, *Ecosystems, *Chesapeake Bay, Biomass, Seasonal variation, Calvert Cliffs Nuclear Power Plant, Barnacles, Amphipods, Bays, Coelenterates.

Wooden panels were located near the surface and at 4.6 m at five stations in the central Chesapeake Bay near the Calvert Cliffs Nuclear Power Plant from 1970 to 1980, to sample the epifaunal community. Fifty-six taxa were identified, but five species consistently accounted for 80-90% of the biomass. These five dominants included a colonial hydroid, two ectoprocts, a barnacle, and a tube-building amphipod. Organisms set from April to December, but both species numbers and biomass peaked in summer, and both showed significant correlation with temperature. Surface biomass peaked in June at 118 g/sq m, 2 months earlier than at the bottom (119 g/sq m). Monthly biomass averaged 49.6 g/sq m at the surface and 50.9 g/sq m at the bottom. Highest biomass values were recorded for bottom panels in the discharge of the Calvert Cliffs Nuclear Power Plant. Ratios of ash-free biomass to total dry weight were lower for bottom panels than for surface panels because of greater coverage of bottom panels by barnacles. (See also W90-03599) (Author's abstract)
W90-03603

BENTHOS.
Dauphin Island Sea Lab., AL.
K. L. Heck.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 977-110, 3 fig, 4 tab, 21 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Benthic fauna, *Chesapeake Bay, *Ecosystems, Biomass, Mollusks, Seasonal variation, Polychaetes, Dissolved oxygen, Helminths, Estuarine sediments, Population density.

Benthic communities near the Calvert Cliffs Nuclear Power Plant in Chesapeake Bay were numerically dominated by polychaetes or, occasionally, nemerteans. In terms of dry weight biomass however, mollusks dominated the standing crops by an order of magnitude. Large differences in recruitment over the years had no apparent affect on the dominance of the major species. The seasonal fluctuation of benthic population abundance peaked in the spring and was lowest in the summer. Benthic abundance and biomass were most dependent on the type of sediment present, although benthic populations also seemed to be affected significantly by the predation of blue crabs and by low concentrations of dissolved oxygen. (See also W90-03599) (Author's abstract)
W90-03604

SHELLFISH.
Academy of Natural Sciences of Philadelphia,

Benedict, MD. Benedict Estuarine Research Lab.
G. R. Abbe.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 111-166, 24 fig, 11 tab, 79 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Ecological effects, *Estuarine fisheries, *Shellfish, *Chesapeake Bay, *Ecosystems, Clams, Oysters, Population dynamics, Population density, Crabs.

The three species of commercially valuable shellfish found in central Chesapeake Bay near Calvert Cliffs are the soft-shell clam Mya arenaria, the blue crab Callinectes sapidus, and the American oyster Crassostrea virginica. Clam populations were sampled along 19 km of shoreline by hydraulic escalator dredge during 7 years from 1971 to 1979. Population size, percent legal size, and distribution fluctuated widely over time. Large numbers of small clams were observed, but few survived. Population density increased with depth to about 4.6 m, but was never enough to support commercial activity. Blue crabs were sampled by pots from 1968 to 1983 at three stations. In 16 years, 66,275 crabs were caught; 50% were male and 76% were legal. Crabs per pot fished ranged from 0.85 in 1968 to 16.86 in 1981 and were significantly correlated with Maryland commercial landings. Differences among years were detected for all 10 catch variables examined, but few differences occurred among stations or between pre-operational and operational periods. A significant long-term decrease in percent males, however, could have serious implications to the crab fishery. Trays of oysters located at various stations from 1970 to 1981 contained four age classes which were examined quarterly for growth, mortality, and meat condition. Growth was greater near the Calvert Cliffs Nuclear Power Plant than elsewhere, but only after 3 years. Although mortalities were not consistent among years, they were similar among stations. The Flag Pond Oyster Bar was surveyed by divers in 1979 and 1983 to determine changes in population structure. Density of legal oysters doubled and sub-legals increased 33 times as a result of increased larval recruitment during the early 1980s. Population size was greater than at any time in the last two decades. (See also W90-03599) (Author's abstract)
W90-03605

FISH.
Academy of Natural Sciences of Philadelphia, PA.
R. J. Horwitz.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 167-224, 10 fig, 19 tab, 33 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Estuarine fisheries, *Fish, *Chesapeake Bay, *Ecosystems, Dissolved oxygen, Salinity, Water temperature, Fish populations, Bass, Menhaden, Population dynamics.

Monthly trawl samples of fish were taken in Chesapeake Bay in the vicinity of the Calvert Cliffs Nuclear Power Plant from 1969 through 1981. Analyses of variation in abundance between individual samples were used to investigate correlations between physical factors (temperature, salinity and dissolved oxygen (DO)) and fish abundance. While significant relationships were found, they may reflect common correlation with other factors that vary with season, station and depth rather than direct causal relationships. Low summer concentrations of DO in deeper water (9 and 12 m) were more frequent during the later years of the study. The distribution of striped bass with respect to DO and temperature was consistent with models of habitat limitations by DO and temperature. Sample abundances within each year were used to estimate annual abundance and age classes of major species. Decreases of several species in the early 1970s may have been due to Tropical Storm Agnes and to decreases in aquatic vegetation; however, the declines in these fish species were not coincident. Measures of overwinter survival of juvenile croaker were correlated with winter severity. Overwinter survival of juvenile spot was lowest in the severe winter of 1976-1977, but there was no consistent relationship between severity of weather and overwinter survival in all years of study. Correlations among annual species abundances did not reveal either strong positive correlations, suggestive of common response to environmental variation, or strong negative correlations which might indicate competitive complementarity. Analyses of relative and absolute abundance of several feeding groups showed decreases in zooplanktivores, species of which mysids are important, piscivores, and feeders on small epifauna and benthos. Size-frequency analyses of menhaden, croaker and spot showed the appearance of juveniles in the fall samples, followed by the appearance of smaller fish in early winter. These smaller fish may have been more slowly growing fish which left shallow nursery grounds later than the other juveniles or may have been late-spawned fish from a different offshore spawning area than the main group of juveniles. (See also W90-03599) (Author's abstract)
W90-03606

ENTRAINMENT STUDIES.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 4C.
W90-03607

IMPINGEMENT STUDIES.
Academy of Natural Sciences of Philadelphia, PA.
For primary bibliographic entry see Field 4C.
W90-03608

THERMAL AND OTHER DISCHARGE-RELATED EFFECTS ON THE BAY ECOSYSTEM.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 4C.
W90-03609

ENVIRONMENTAL STUDIES IN PORT VALDEZ, ALASKA: A BASIS FOR MANAGEMENT.
For primary bibliographic entry see Field 5C.
W90-03610

NATURAL AND HISTORIC SETTING.
National Ocean Service, Anchorage, AK. Ocean Assessments Div.
M. J. Hameedi.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 1-15, 1 fig, 2 tab, 24 ref.

Descriptors: *History, *Arctic zone, *Alaska, *Valdez, *Natural resources, Fjords, Social aspects, Prince William Sound, Alaska pipeline.

The Chugiak eskimos are the earliest known people who lived and traded with neighboring communities in the Prince William Sound region, including what is now known as Port Valdez. In 1793 and 1794, Captain George Vancouver adopted the name Port Valdez in his survey maps of the North American coastline between the thirty-fifth and sixtieth parallels of latitude. Port Valdez is located in the northeastern portion of Prince William Sound, southcentral Alaska. It is a deep, steep-walled, and partially-filled glacial fjord in the Chugach Mountains. It trends east-west and is approximately 22 km long and 5 km wide. Port Valdez is in a tectonically-active region; the epicenter of the 1964 Great Alaska Earthquake was 70 miles west of Port Valdez. The port waters receive a large amount of sediment during the summer, much of which originates in Lowe River, Mineral Creek, and Valdez Glacier Stream. Tides are of the mixed, semi-diurnal type, with a maximum range of 5.3 m. Water circulation is typically that of a positive estuarine fjord. The area is noted for sport fishing and hunting activities, but not for commercial fishing. Four seabird colonies have been identified. Since early in the 1900's Port Valdez has been important as an ocean terminus of inland Alaska routes because it is an ice-free, deep-water port. In recent years, it has gained in importance as the terminus of the Alaska oil pipeline, which handles nearly the entire production of the Alaska North Slope crude oil. (See also W89-03610) (Lantz-PTT)
W90-03611

PROCESSES OF BALLAST WATER DISPERSAL.
ENTRIX, Inc., Anchorage, AK.
For primary bibliographic entry see Field 5E.
W90-03613

SEDIMENTATION PROCESSES.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 2J.
W90-03614

WATER COLUMN PRODUCTION.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 2H.
W90-03615

INTERTIDAL ZONE.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5C.
W90-03616

SUBTIDAL BENTHOS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
H. M. Feder, and S. C. Jewett.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 165-202, 7 fig, 4 tab, 81 ref.

Descriptors: *Arctic zone, *Alaska, *Valdez, *Port facilities, *Alaska oil pipeline, Fjords, Annelids, Mollusks, Arthropods, Shrimp, Crabs, Sculpin, Fish, Sole, Pollock, Primary productivity, Biomass, Oil spills, Wastewater disposal.

The subtidal benthic fauna of Port Valdez, a turbid outwash fjord, is similar to that of other fjords of south-central and southeastern Alaska. The infauna is dominated by annelids with mollusks and arthropod crustaceans of secondary importance. Epifaunal organisms are relatively sparse, but pandalid shrimp and juvenile Tanner crab are occasionally common. Bottom fishes are uncommon; sculpins, flathead sole, and juvenile pollock occur most frequently. Infaunal production estimates for Port Valdez are relatively low, varying from 0.3-1.7 g C/sq m/yr. These low values are similar to those estimated for Alaskan shelf systems where a large proportion of the primary production is grazed before settling to the bottom. The deep benthos of Port Valdez also appears to be largely uncoupled from water-column production. Comparison of Port Valdez with other northern oxic fjords supports the generalization that fjordic systems are not readily comparable. However, an attempt has been made to show some of the similarities and dissimilarities between the port and other northern oxic fjords. The types and numbers of infaunal taxa are similar in all oxic Alaskan fjords examined, but abundance and biomass tend to be higher in tidewater glacier fjords than in turbid outwash fjords such as Port Valdez. The benthic biomass of all of these fjords is much lower than that of the adjacent shelf. The disturbance events identified in Port Valdez (a major earthquake in 1964, construction of a road across the tidal flats in 1974, completion of the Alaska pipeline terminal in 1977, and tanker loading with associated minor spills and discharge of treated ballast water since then) have resulted in a benthic community in a continuing state of flux. The benthos appears to support the hypothesis that macrobenthic communities in frequently disturbed environments are more resilient to perturbation than communities in constant environments. (See also W89-03610) (Lantz-PTT)
W90-03617

FISHERIES RESOURCES.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
For primary bibliographic entry see Field 5C.
W90-03618

WATERBIRDS AND MARINE MAMMALS.
Fish and Wildlife Service, Anchorage, AK.
For primary bibliographic entry see Field 5C.
W90-03619

HYDROCARBON ACCUMULATIONS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5B.
W90-03620

HYDROCARBON BIOCONVERSIONS: SOURCES, DYNAMICS, PRODUCTS AND POPULATIONS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5B.
W90-03621

NATURAL AND ANTHROPOGENIC DISTURBANCES AT THE ECOSYSTEM LEVEL.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 4C.
W90-03623

RELATIONSHIP OF ESTUARINE PLANT CONTAMINANTS TO EXISTING DATA BASES.
European Research Office, London (England).
For primary bibliographic entry see Field 5C.
W90-03765

CLASSIFICATION OF SALT-AFFECTED LAND IN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
B. G. Williams, and P. R. Bullock.
CSIRO Technical Memorandum 89/8, August 1989. 11p, 4 fig, 13 ref.

Descriptors: *Saline soils, *Classification, *Australia, *Wetlands, *Salinity, Saline groundwater, Scalds, Irrigation, Land management.

Classification schemes currently used in Australia have been examined in terms of the criteria used at different levels. It is recognized that, with the exception of 'coastal marshes' all types of salt-affected land are common to both pre-European and post-European settlement. The terms 'primary salinity' and 'secondary salinity' are used in this historical sense. The term 'wetland salinity' is excluded completely. The land use terms 'dryland salinity' and 'irrigation salinity' are retained because of their strong community acceptance. In the case of irrigation salinity; it is suggested that the term 'salt pan' should include all those forms analogous to the salt pan/salt flat types. That is, 'salt pans' have a more or less permanently wet surface and cover a wide range of vegetative types and degree of surface cover. A 'secondary, irrigation, salt pan' would refer to swamp areas developing in the immediate vicinity of irrigation areas while saline groundwater discharge in swales of mallee dune country could be referred to as 'secondary dryland salt pans'. The only new terminology introduced is the division of 'scalds' into 'seepage scalds' and 'dry scalds' in order to emphasize the very different processes involved in their development. If thought necessary, a further class could be added to the Primary Salinity class to accommodate the Soil Conversation Authority of Victoria (SCAV) requirements to distinguish between soils having saline, clay or loam subsoils. Although these are not easily recognizable they do have considerable implications for land management. (Lantz-PTT)
W90-03813

WINYAH BAY, GEORGETOWN, SOUTH CAROLINA, DATA COLLECTION SURVEY REPORT.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
T. L. Fagerburg.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-89-23, November 1989. Final Report. 126p, 15 fig, 22 tab, 35 plates, append.

Descriptors: *Estuaries, *Dredging, *Spoil banks, *Wetlands, *Bays, *Winyah Bay, *Data collections, South Carolina, Water level, Flow velocity, Tidal currents, Suspended sediments, Turbidity, Bed load, Salinity, Mixing, Marshes.

Water levels, current speeds and directions, salinities, suspended sediment concentrations, bed sediment characteristics, and densities were measured in Winyah Bay, SC, in January 1989. The prototype data were collected as part of a study to evaluate the effects of a dredged material placement operation to create a wetland marsh in the bay. The following observations were made of the data: (1) there appears to be a slight decrease in the maximum range of water surface elevation (tide, 0.15 ft) from the lower bay water level recorder to the upper bay water level recorder; (2) the maximum velocities observed during the survey occurred at the strength of ebb of the tidal cycle. The maximum recorded velocity was 5.5 ft/sec (fps); (3) suspended sediment concentrations in the channel were generally greater near the bottom. The greatest suspended sediment concentration observed during the survey period was 420 mg/L; (4) long-term sampling of the suspended sediment recorded a maximum concentration of 140 mg/L. This concentration occurred during the predredging period (October-November 1988). The long-term suspended sediment sampling indicated no significant changes in concentrations resulting from the dredging operations; (5) changes in the bottom material composition over time indicate that most of the very fine sediments are not retained within the majority of the sampling areas but appear to be displaced by the natural circulation patterns within the bay; and (6) salinity values indicated that the lower portion of the bay could be described as being well mixed, while the upper portions could be described as being partly to well mixed. (Lantz-PTT)
W90-03819

EFFECTS OF SUSPENDED SEDIMENTS ON EGG PRODUCTION OF THE CALANOID COPEPOD ACARTIA TONSA.
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
For primary bibliographic entry see Field 2J.
W90-03918

ENVIRONMENTS AND SUBENVIRONMENTS IN THE INTERTIDAL SECTOR OF THE BAY OF SAN SIMON: VIGO ESTUARY (PONTEVEDRA)--CHARACTERISTIC SEDIMENTARY SEQUENCES (MEDIOS Y SUBMEDIOS EN EL SECTOR INTERMAREAL DE LA ENSENADA DE SAN SIMON: RIA DE VIGO (PONTEVEDRA)--SECUENCIAS SEDIMENTARIAS CARACTERISTICAS).
Santiago Univ., Vigo (Spain).
For primary bibliographic entry see Field 2J.
W90-03929

MARINE CIRCULATION ON THE EBRO CONTINENTAL SHELF DETERMINED IN EQUAL PARTS FROM THE DISTRIBUTION OF WATER MASSES AND THE ORGANIC MICROCONTAMINANTS IN THE SEDIMENT (CIRCULACION MARINA EN LA PLATAFORMA CONTINENTAL DEL EBRO DETERMINADA A PARTIR DE LA DISTRIBUCION DE MASAS DE AGUA Y LOS MICROCONTAMINANTES ORGANICOS EN EL SEDIMENTO).
Instituto de Ciencias del Mar, Barcelona (Spain).
For primary bibliographic entry see Field 2J.
W90-03930

STUDY OF THE SUSPENDED MATERIAL IN THE GULF OF CADIZ (ESTUDIO DE LA MATERIA EN SUSPENSION EN EL GOLFO DE CADIZ).
Instituto de Ciencias del Mar, Barcelona (Spain).
For primary bibliographic entry see Field 2J.
W90-03931

DECISION SUPPORT FOR ESTUARINE WATER QUALITY MANAGEMENT.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-03978

NUTRIENTS AND PHYTOPLANKTON DISTRIBUTIONS DURING SPRING IN THE AEGEAN SEA.
National Centre for Marine Research, Athens (Greece).
N. Friligos, and M. Karydis.
Vie et Milieu (Life and Environment) VIMID2, Vol. 38, No. 2, p 133-143, June 1988. 5 fig, 8 tab, 27 ref.

Descriptors: *Aegean Sea, *Phytoplankton, *Distribution patterns, *Nutrients, *Estuarine environment, Spatial distribution, Physicochemical analysis, River mouth, Species composition, Population density, Diatoms, Salinity, Species diversity, Vertical distribution, Hydrographs.

Physico-chemical parameters and phytoplankton distributions were studied during the spring phytoplankton bloom in Kavala and Alexandroupolis Gulfs, both influenced by river waters. Salinity, temperature and nutrients were affected by uneven river discharges and some significant correlations with phytoplankton growth were found. The hydrographical structure near the Evros River is heterogeneous. Data indicated that phytoplankton abundance inside the Evros River plume were higher than those of the Eastern Mediterranean. Phytoplankton community structure was dominated by the diatom Rhizosolenia hebetata in Kavala Gulf, whereas, a very intense bloom of Skeletonema costatum was observed in Alexandroupolis Gulf. The relationships between phytoplankton parameters, especially dominance and diversity, are also discussed. For example, regression analysis revealed that cell number increases and diversity decreases with increasing nutrient concentrations, except by silicates. Cell number and diversity were highly correlated with temperature, ammonium and silicates outside the Evros River plume. However inside the Evros River plume there is a correlation between the cell number and the salinity, but not with the nutrients concentration. (Author's abstract)
W90-04027

MEMBRANE FATTY ACID AND VIRULENCE CHANGES IN THE VIABLE BUT NONCULTURABLE STATE OF VIBRIO VULNIFICUS.
North Carolina Univ. at Charlotte. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-04031

OCCURRENCE AND CHARACTERISTICS OF AGGLUTINATION OF VIBRIO CHOLERAE BY SERUM FROM THE EASTERN OYSTER, CRASSOSTREA VIRGINICA.
Food and Drug Administration, Dauphin Island, AL. Fishery Research Branch.
For primary bibliographic entry see Field 5B.
W90-04033

RARE EARTH ELEMENTS IN SAANICH INLET, BRITISH COLUMBIA, A SEASONALLY ANOXIC BASIN.
Cambridge Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2H.
W90-04055

BIOGEOCHEMICAL FACTORS THAT INFLUENCE THE STABLE NITROGEN ISOTOPE

RATIO OF DISSOLVED AMMONIUM IN THE DELAWARE ESTUARY.
Carnegie Institution of Washington, DC. Geophysical Lab.
L. A. Cifuentes, M. L. Fogel, J. R. Pennock, and J. H. Sharp.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 10, p 2713-2721, October 1989. 9 fig, 1 tab, 42 ref. NSF OCE 86-01616. NOAA Office of Sea Grant NA 86AA-D-SG040.

Descriptors: *Estuaries, *Fate of pollutants, *Stable isotopes, *Nitrogen, *Ammonium, *Delaware River Estuary, *Cycling nutrients, Geochemistry, Microbial degradation, Numerical analysis, Model studies, Algal growth.

The transport and cycling of sewage derived NH4(+) in the Delaware Estuary was investigated. The isotopic composition (sigma N15) of dissolved ammonium (NH4(+)) in the Estuary was related to reactions in the nitrogen cycle occurring in different regions of the estuary and at different rates throughout the year. The range of values at any one location (as great as +10 to +40 o/oo) was dependent on either nitrification, algal uptake, and microbial remineralization, or a combination of these reactions. Specifically, observations of isotopic discrimination during nitrification in the riverine portion of the estuary were similar to those reported in other estuaries. The first calculation of the isotopic fractionation during algal uptake in the field is reported. Algal assimilation of NH4(+) in the estuary had an estimated fractionation factor of -9.1 o/oo. This estimated fractionation factor for the field data and fractionation factors measured in culture (-14 to -20 o/oo) were compared in a numerical simulation of NH4(+) transport and uptake in the estuary. Model results for the period of the spring bloom resembled the field data more closely when the isotopic fractionation estimated with the in situ data was used rather than the greater isotopic fractionations measured in culture. (Author's abstract)
W90-04056

GEOCHEMICAL ANOMALIES IN SEDIMENTS ON THE SHELF NEAR THE LAGOON OF VENICE, ITALY.
New South Wales Univ., Kensington (Australia). Dept. of Applied Geology.
For primary bibliographic entry see Field 5B.
W90-04060

PESTICIDES AND PCBS IN OYSTERS FROM MAZATLAN, SINALOA, MEXICO.
California State Dept. of Fish and Game, Monterey. Marine Pollution Studies Lab.
For primary bibliographic entry see Field 5B.
W90-04065

MAN'S IMPACT ON THE ECOSYSTEM OF THE BALTIC SEA: ENERGY FLOWS TODAY AND AT THE TURN OF THE CENTURY.
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 6G.
W90-04081

ECOLOGICAL OBSERVATIONS ON PLANKTON OF THE LOIRE ESTUARY (FRANCE).
Nantes Univ. (France). Lab. de Biologie Marine.
Y. Rince, V. Martin-Jezequel, and B. Ravail.
Cahiers de Biologie Marine CBIMA5, Vol. 30, No. 2, p 201-216, 1989. 7 fig, 3 tab, 42 ref.

Descriptors: *Plankton, *Phytoplankton, *Zooplankton, *Estuarine environment, *France, Seasonal variation, Tides, Salinity, Species distribution, Spatial variation, Species diversity.

Hydrological and planktonic studies were performed in the Loire estuary in 1981-1982. Hydrological and biological samples were collected at three stations in three distinct zones of the estuary. Different regimes were investigated during spring-tide and neap-tide at low flow, mean flow and high flow. For each station, samples were collected every two hours, during a 12 hour tidal cycle. Three supplementary investigations were made in May, June and July. Hauls were made at 1 m below the surface, against the current, with a 50 micrometer mesh net for phytoplankton and a 200 micrometer net for zooplankton. The hydrological regime of the river produces variations in the seasonal cycle of the plankton, while spring and neap-tides, through suspended matter and water mixing, cause different patterns of spatial distribution of plankton. In the lower zone of the Loire estuary, sea water brings marine plankton (about 60 species except meroplanktonic forms), while freshwater provides limnetic forms to the inner zone (about 100 species). The impact of salinity on the number of species per station is subject to river regime and tidal cycles. Neritic plankton reach the mesohaline part of the estuary during spring tides and at low river regimes. At mesohaline and oligohaline stations, the algal biomass shows a seasonal trend with increasing river flow, characterized increasing phytoplanktonic numbers and chlorophyll-a contents. The zooplankton biomass at one station is also affected by river flow. Numbers increase during high waters and decrease during mean and low waters. (Mertz-PTT)
W90-04089

ENVIRONMENTAL CORRELATES WITH AMPHIPOD DISTRIBUTION IN A SCOTTISH SEA LOCH.
Marine Lab., Aberdeen (Scotland).
M. R. Robertson, S. J. Hall, and A. Eleftheriou.
Cahiers de Biologie Marine CBIMA5, Vol. 30, No. 2, p 243-258, 1989. 4 fig, 5 tab, 32 ref.

Descriptors: *Fjords, *Scotland, *Aquatic productivity, *Amphipods, Organic carbon, Chlorophyll a, Species diversity, Population density, Bottom sediments, Water depth.

Over the period 1969 to 1980, 34 stations (both inter and subtidal) were visited in Loch Eve, a fjordic sea loch on the west coast of Scotland. Amphipod densities were determined along with sediment particle size and levels of organic carbon and chlorophyll a. A total of 53 amphipod species representing two suborders and 23 families was collected from the Loch Ewe area during the survey. The Gammaridean suborder was by far the most dominant, represented by 22 families to which Lysianassids, Oedicerotids, Ampeliscids, Pontoporeids, and Phoxocephalids contributed most species. During the survey, specimens were collected from different sedimentary environments ranging from medium sandy intertidal deposits to fine or very fine sands and silts at depths in excess of 50 m. Multivariate analysis of these data indicates that depth and sediment organic carbon levels are the major determinants of amphipod assemblages in the loch, in contrast to previous studies that have variously implicated temperature, sediment granulometry and food availability. (Author's abstract)
W90-04090

LONG-TERM CHANGES IN NUTRIENTS, WEED MATS AND SHOREBIRDS IN AN ESTUARINE SYSTEM.
Aberdeen Univ. (Scotland). Culterty Field Station.
D. Raffaelli, S. Hull, and H. Milne.
Cahiers de Biologie Marine CBIMA5, Vol. 30, No. 2, p 259-270, 1989. 6 fig, 2 tab, 26 ref.

Descriptors: *Eutrophication, *Estuarine environment, *Aquatic productivity, *Amphipods, *Scotland, *Marine algae, Enteromorpha, Corophium, Agricultural watersheds, Birds, Eutrophication, Mud flats, Biomass.

Long-term data sets on agricultural methods, river nutrients, biomass of macro-algal mats and numbers of shorebirds are analyzed for the Ythan estuary, Aberdeenshire, Scotland. The results suggest a 2-3 fold increase of nitrogen in river water over a 25-year period, associated with an increase in the proportion of land under cereal crop production. Biomass of the green seaweed Enteromorpha has also increased over this period and now forms dense mats in much of the estuary. The abundance of the amphipod Corophium volutator is reduced under weed mats but there are at present sufficient unweeded refuge areas between the mats to maintain an highly productive invertebrate community. A general increase in mudflat invertebrate productivity may account for increases in the numbers of several of species shorebird on the Ythan during the study. However, if weed mats become too extensive, these highly productive refuges may disappear altogether with dramatic effects on the general ecology of the estuary. (Author's abstract)
W90-04091

FACTORS AFFECTING ESTUARINE MEIOBENTHIC ASSEMBLAGE STRUCTURE: A MULTIFACTORIAL MICROCOSM EXPERIMENT.
Marine Biological Association of the United Kingdom, Plymouth (England).
For primary bibliographic entry see Field 2H.
W90-04097

BIVALVE SUSPENSION-FEEDING DYNAMICS AND BENTHIC-PELAGIC COUPLING IN AN EUTROPHICATED MARINE BAY.
Goeteborg Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-04098

BACTERIOPLANKTON BIOMASS AND PRODUCTION DURING DESTRATIFICATION IN A MONOMICTIC EUTROPHIC BAY OF A TROPICAL LAGOON.
Centre de Recherches Oceanographiques, Abidjan (Ivory Coast).
For primary bibliographic entry see Field 5C.
W90-04114

REMOTE SENSING AND NUMERICAL MODELING OF SUSPENDED SEDIMENT IN LAGUNA DE TERMINOS, CAMPECHE, MEXICO.
South Carolina Univ., Columbia. Dept. of Geography.
For primary bibliographic entry see Field 7B.
W90-04191

MODELING FUTURE TRENDS IN WETLAND LOSS AND BROWN SHRIMP PRODUCTION IN LOUISIANA USING THEMATIC MAPPER IMAGERY.
National Marine Fisheries Service, Miami, FL. Southeast Fisheries Center.
J. A. Browder, L. N. May, A. Rosenthal, J. G. Gosselink, and R. H. Baumann.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 45-59, April/June 1989. 11 fig, 23 ref.

Descriptors: *Model studies, *Remote sensing, *Wetlands, *Coastal marshes, *Estuarine fisheries, *Louisiana, *Satellite technology, *Landsat Thematic Mapper, Shrimp, Productivity.

The land-water interface of coastal marshes may influence the production of estuarine-dependent fisheries more than the area of these marshes. To test this hypothesis a spatial model to explore the dynamic relationship between land-water interface and degree of land loss in disintegrating coastal marshes of Louisiana's Barataria, Terrebonne, and Timbalier basins was developed. By calibrating the model with Landsat Thematic Mapper satellite imagery, a parabolic relationship between land-water interface and marsh disintegration was determined. Aggregated simulation data suggested that the land-water interface in the study area will soon reach its maximum and then decline. A statistically significant positive linear relationship between brown shrimp catch and total interface length over the past 28 years was found. This relationship suggests that shrimp yields will decline when interface declines, possibly beginning about 1995. (Author's abstract)
W90-04192

PLUME OF THE YUKON RIVER IN RELATION TO THE OCEANOGRAPHY OF THE BERING SEA.
Alaska Univ., Fairbanks. Geophysical Inst.

For primary bibliographic entry see Field 2E.
W90-04194

TROPICAL STORM SURGE FORECASTING IN THE NATIONAL WEATHER SERVICE.
National Weather Service, Silver Spring, MD. Techniques Development Lab.
C. P. Jelesnianski.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 65-75, 2 fig, 5 ref.

Descriptors: *Computer programs, *Flood forecasting, *Storm surges, *Tropical cyclones, *Forecasting, *Hydrologic models, Data interpretation, SLOSH, SPLASH, Computer models, Coasts, Storms.

A storm surge is an abnormal rise of water generated by a tropical storm is a long gravity wave and not to be confused with short period wind waves, surf, swell, etc. Along a coastline, the significant surge has a reach of about 100 miles with a duration of about 6 hours. In any one particular geographical area, observed surge data is scarce due to rarity of storm events. Consequently, dynamic surge modeling is used to ascertain flooding from tropical storms. All dynamic surge models can deal with both planning and forecasting. A dynamic surge model will numerically solve a set of partial differential equations of motion, according to input data. When using a surge model in a forecast mode it must be complete in the sense of storing prepared basin data, pre-set values for coefficients in the equations of motion, and the availability of an adequate storm model. The only input data required from a user are: (1) simple storm parameters for the required lead time of an in-situ storm, and (2) the initial and quiescent height or datum of water surfaces in the absence of a storm. The National Weather Service (NWS) uses two surge models: (1) SPLASH, and (2) SLOSH. The SPLASH model is restricted to surge computations on a basin truncated from a large sea, including a 600 miles length of coastline. The equations of motion are simplified since inland inundation and extreme shallow depths are not considered. The output format of the model are: (1) a line envelope of highest waters on the coast during the storm's history, and (2) a time-history of coastal surges, that is, a time-history of surges for any point on the coast. The SLOSH model is more comprehensive. It allows overtopping of barriers and coastal dunes, inland flooding from the sea, channel and other sub-grid size flow. The equations of motion are more complicated with nonlinear flow to account for inland inundation, extreme shallow depths, and overtopping of barriers. The output format are: (1) a surface envelope of highest waters on the entire basin during a storm's existence, (2) snapshots of water heights on the entire basin at selected time intervals, and (3) continuous time histories of surges at selected points on the basin. (See also W90-04308)(Lantz-PTT)
W90-04312

EXPERIMENTS IN WASTEWATER POLISHING IN CONSTRUCTED TIDAL MARSHES: DOES IT WORK. ARE THE RESULTS PREDICTABLE.
Lehigh Univ., Bethlehem, PA. Center for Marine and Environmental Studies.
For primary bibliographic entry see Field 5D.
W90-04465

OVERVIEW OF THE HUDSON RIVER ESTUARY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
J. C. Cooper, F. R. Cantelmo, and C. E. Newton.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 11-24. 9 fig, 3 tab, 43 ref.

Descriptors: *Thermal powerplants, *Nuclear powerplants, *Environmental effects, *Hudson River Estuary, *Estuaries, *Tidal powerplants, *Saline-freshwater interfaces, *Water pollution effects, New York, Tidal currents, Temperature, Pesticides, Industrial wastes.

An overview of the geography, hydrology, and physicochemistry of the Hudson River estuary as a basis for understanding the life histories of fishes and other aquatic organisms is presented. Salinity distribution in the estuary is mainly influenced by freshwater flow and tidal currents. Two-thirds of the freshwater inflow is controlled by a dam near Troy, New York, 243 river kilometers above the Battery in New York City; this dam defines the upper limit of the estuary. South of Troy Dam, flow increases linearly through the remaining third of the watershed. Even in times of high freshwater flow, however, net flow is dominated by tidal flow. The estuary is generally limnetic (<0.3ppt salinity) above km 80, oligohaline (0.3-5ppt) between km 80 and 40, and mesohaline (5-18ppt) below km 40. The salt front (0.1ppt) is generally found near km 80, but can move rapidly as freshwater flow changes. The estuary is stressed by sewage and industrial discharges, polychlorinated biphenyls, pesticides, and agricultural chemicals, though loadings of some pollutants have abated in recent years. Major power plants are sited in the mesohaline zone, where tidal energy and biological productivity are large. By their withdrawal of large volumes of river water, which they return at elevated temperatures, power plants have potentially large effects on the organisms that are found in these waters. The prevailing opinion among many researchers is that fluctuations in salinity, temperature, and freshwater input are dominant influences on the biota of the Hudson River. For example, salinity patterns are important to the distribution of fish and benthos; temperature patterns determine species distributions, and reproductive strategies. Because of their size and placement, power plants have the potential to affect all of these factors. (See also W90-04505) (Author's abstract)
W90-04506

HISTORICAL PERSPECTIVE ON FISH SPECIES COMPOSITION AND DISTRIBUTION IN THE HUDSON RIVER ESTUARY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
C. A. Beebe, and I. R. Savidge.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 25-36. 3 tab, 75 ref.

Descriptors: *Hudson River Estuary, *Estuarine fisheries, *Environmental effects, *Saline-freshwater interfaces, Species composition, Salinity, Geology.

Research on the fish fauna of the Hudson River estuary has been conducted for over 160 years, but most of the knowledge of species composition has been obtained since 1974. One hundred forty species have been reported for the estuary south of Albany. Species composition has been influenced by both geological and human activities. Species composition is relatively distinctive, although variable, in each of three ecological zones (marine, brackish, freshwater); however, species often overlap these zones. On an annual basis, species composition is influenced by salinity and season. The highest numbers of species occur in the brackish zone and during summer. (See also W90-04505) (Author's abstract)
W90-04507

EVALUATION OF THE HUDSON RIVER ECOSYSTEM IN RELATION TO THE DYNAMICS OF FISH POPULATIONS.
Savannah River Ecology Lab., Aiken, SC.
J. B. Gladden, F. R. Cantelmo, J. M. Croom, and R. Shapot.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 37-52. 6 fig, 3 tab, 74 ref. DOE and University of Georgia's Institute of Ecology Contract DE-AC09-76SR00819.

Descriptors: *Environmental effects, *Hudson River Estuary, *Estuarine fisheries, *Estuarine environment, Plankton, Invertebrates, Benthos, Algae, Seasonal variation, Salinity, Temperature.

Components of the Hudson River estuary ecosystem were evaluated to elucidate aspects of trophic function that could contribute to the observed variability in fish population abundance. Over half (55%) of the organic carbon available in the estuary was imported from the surrounding watershed, while phytoplankton (17%) and benthic algae (14%) provided most of the remaining food base. Allochthonous carbon inputs were highest in spring as a result of high freshwater flow rates, and algal production was highest in summer during peak insolation. Invertebrate populations provide food for most fish species; benthic invertebrate communities were found to provide a more temporally stable food base than either epibenthic invertebrates or zooplankton, both of which showed large seasonal changes in abundance. Dominant resident fish species primarily used shallower areas of the estuary, feeding omnivorously or on the benthic and epibenthic invertebrates. Migrant species occurred in all major estuarine habitants, but dominated the fish community in deepwater portions of the estuary and depended on zooplankton and other fish for food. Migrant fish species appeared to have larger year-to-year variations in abundance than did resident species, possibly as a result of less stable (less predictable) food resources for the migrant fish than for the resident fish. Overall, freshwater flow rates may be the single largest factor influencing trophic functioning in the estuary. Such flows strongly influence organic carbon inputs from the watershed, phytoplankton standing crops, and the spatiotemporal distributions of salinity and temperature in the estuary. (See also W90-04505) (Author's abstract)
W90-04508

DISTRIBUTIONS OF EARLY LIFE STAGES OF STRIPED BASS IN THE HUDSON RIVER ESTUARY, 1974-1979.
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
J. Boreman, and R. J. Klauda.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 53-58. 3 fig, 21 ref.

Descriptors: *Environmental effects, *Hudson River Estuary, *Estuarine fisheries, *Striped bass, Fish eggs, Life history studies, Fish growth, Seasonal variation.

Spatial and temporal distribution patterns for early life stages of striped bass in the Hudson River estuary during 1974-1979 are described. For these years, the early life stages exhibited a low annual variability in the patterns. Eggs were collected in all sampling regions of the estuary, usually from the first week of May until early June. Yolk-sac larvae were found during the same period and in the same regions as were eggs, but peak larval densities were consistently upriver from the peak egg densities. Post-yolk-sac larvae were collected from late May to late July and generally in the same regions as yolk-sac larvae. Juveniles were found from late June into August distinctly downriver from the larval life stages. Estimates of year-class strength varied by less than twofold during 1974-1979, which makes it difficult to relate distribution patterns for the early life stages to year-class success. (See also W90-04505) (Author's abstract)
W90-04509

STOCK CHARACTERISTICS OF HUDSON RIVER STRIPED BASS.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
T. B. Hoff, J. B. McLaren, and J. C. Cooper.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 59-68. 7 tab, 36 ref.

Descriptors: *Thermal powerplants, *Nuclear powerplants, *Environmental effects, *Hudson River Estuary, *Estuarine fisheries, *Striped bass, Life history studies, Growth, Environmental effects.

Striped bass, because of their tremendous popularity both commercially and recreationally, were a principal focus of the Hudson River power plant case. Between 1976 and 1979, over 23,000 age-II and older striped bass were studied as one facet of an extensive research program on the spring population in the Hudson River. Samples were collected from the overwintering as well as the spawning portion of the striped bass population, and included immature as well as mature fish. At least 12 age-groups contributed to spawning each year (some fish live to 18 years of age). Of these 12, age-groups III, IV, and V usually were most abundant, but the percentage of the population represented by any single age-group varied as the result of fluctuations in year-class strength. Males first became sexually mature at age II and females at age IV. Fast-growing individuals within a year class tended to mature earlier. Fecundity increased with the size of fish, reaching an observed maximum of about 3 million eggs per female. Although significant annual variations in maturity and growth were detected for Hudson River striped bass, there was no evidence of a consistent change in either variable that might be associated with increasing power plant operations (over 3,700 MW of electrical generating capacity came on-line during 1974-1976) and a reduction in striped bass abundance. Age at maturity and age structure are the two life history components that differ the most between the Hudson River population and other striped bass populations. (See also W90-04505) (Author's abstract)
W90-04510

ESTIMATES OF ENTRAINMENT MORTALITY FOR STRIPED BASS AND OTHER FISH SPECIES INHABITING THE HUDSON RIVER ESTUARY.
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
For primary bibliographic entry see Field 8I.
W90-04515

SURVIVAL OF FISHES AFTER IMPINGEMENT ON TRAVELING SCREENS AT HUDSON RIVER POWER PLANTS.
EA Engineering, Science, and Technology, Inc., Middletown, NY.
For primary bibliographic entry see Field 8I.
W90-04517

IMPLICATIONS OF POWER PLANT MORTALITY FOR MANAGEMENT OF THE HUDSON RIVER STRIPED BASS FISHERY.
Fish and Wildlife Service, Ann Arbor, MI.
For primary bibliographic entry see Field 8I.
W90-04523

WHAT WE LEARNED ABOUT THE HUDSON RIVER: JOURNEY TOWARD AN ELUSIVE DESTINATION.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 6A.
W90-04528

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: III. POLY(ACRYLIC ACID) AND SUBSTITUTED POLY(ACRYLIC ACID) HOMO, CO, AND TERPOLYMER MEMBRANES.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
A. J. van Reenen, and R. D. Sanderson.
Water SA WASADV, Vol. 15, No. 4, p 247-252, October 1989. 6 fig, 1 tab, 16 ref.

Descriptors: *Membrane processes, *Water treatment, *Polymers, Comparison studies, Acrylic acids, Salt rejection, Reverse osmosis, Membrane separation technology.

A series of acrylic acid and substituted acrylic acid homo-, co-, and terpolymers was synthesized. These polymers were used as polyelectrolytes in dynamically formed hydrous zirconicum (iv) oxide-polyelectrolyte membranes to be applied for the recovery of usable water from effluents. Substitution of the acrylic acid alpha-hydrogen was done to increase the number of carboxylic acid groups per monomer unit and to change the acid strength of the acrylic acid carboxylic acid group. None of these changes improved the salt rejection of these membranes over that achieved with commercially used poly(acrylic acid). Improvement in rejection did occur when a hydrophobic monomer, vinyl acetate, was used in conjunction with acrylic acid in a copolymer dynamic membrane. (See also W90-03994) (Author's abstract)
W90-03993

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: IV. MALEIC ANHYDRIDE COPOLYMERS.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
A. J. van Reenan, R. D. Sanderson, and N. A. Dowler.
Water SA WASADV, Vol. 15, No. 4, p 253-255, October 1989. 1 fig, 1 tab, 7 ref.

Descriptors: *Membrane processes, *Water treatment, *Polymers, Comparison studies, Electrolytes, Salt rejection, Reverse osmosis, Membrane separation technology, Maleic anhydride copolymers.

A series of maleic anhydride copolymers were synthesized (poly(maleic anhydride-co-acrylic acid), poly(maleic anhydride-co-itaconic acid), poly(maleic anhydride-co-vinyl sulfonic acid), poly(maleic anhydride-co-vinyl acetate), and poly(maleic anhydride-co-vinyl alcohol)). These copolymers were used as polyelectrolytes in dynamically formed hydrous zirconium (IV) oxide-polyelectrolyte membranes to be applied in processes for the recovery of usable water. All the copolymers formed dynamic membranes. Sodium nitrate rejection ranged from 58.3-89.2%. The vinyl acetate (89.2%) and vinyl alcohol (88.2%) preparations had rejection percentages comparable to that of commercial poly(acrylic acid) (90%). The rejection capabilities of these membranes were not governed solely by the charge density of the membranes, but were due in part to the presence of hydrophobic groups or sections on the membrane-forming polyelectrolyte. (See also W90-03993) (Rochester-PTT)
W90-03994

ION EXCHANGE RESINS. JANUARY 1988-DECEMBER 1988 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-852883. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 105 p. Supersedes PB88-857719.

Descriptors: *Bibliographies, *Wastewater treatment, *Water treatment, *Ion exchange, *Resins, *Desalination, Literature review, Regeneration, Waste recovery, Separation techniques.

This bibliography contains 174 citations concerning preparation, properties, and applications of ion exchange resins. Applications include water and waste treatment; chemical recovery, separation, purification, and catalysis; desalination; and ore treatment and recovery. Regeneration and disposal of ion exchange resins are also covered. (See also W90-04487) (Author's abstract)
W90-04486

ION EXCHANGE RESINS. OCTOBER 1983-DECEMBER 1987 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-852875. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 198 p.

Descriptors: *Bibliographies, *Wastewater treatment, *Water treatment, *Ion exchange, *Resins, *Desalination, Literature review, Regeneration, Waste recovery, Separation techniques.

This bibliography contains 430 citations concerning the preparation, properties, and applications of ion exchange resins. Applications include water and waste treatment; chemical recovery, separation, purification, and catalysis; desalination; and ore treatment and recovery. Regeneration and disposal of ion exchange resins are also covered. (See also W90-04486) (Author's abstract)
W90-04487

3B. Water Yield Improvement

ECONOMIC ANALYSIS OF HARMFUL AND BENEFICIAL ASPECTS OF SALTCEDAR.
Great Western Research, Inc., Mesa, AZ.
Final Report, September 1989. 143p, 11 fig, 69 tab, 1 map, 206 ref. Bureau of Reclamation Contract 8-CP-30-05800.

Descriptors: *Phreatophytes, *Salt cedar, *Water resources management, *Economic aspects, *Ecological effects, Social aspects, Ecosystems, Water use, Wildlife, Habitats.

The objective of this report is to evaluate the harmful and beneficial impacts of a biological control program for deciduous salt cedar. This objective was accomplished through the quantification of economic, environmental and social impacts at three levels of control, two types of replacement vegetation, and at two points in time after control is initiated. Salt cedar is a phreatophyte which has been defined as a plant that obtains its water supply directly from the water table or through the capillary fringe. In general, phreatophytes are located along rivers and lakes where shallow groundwater is easily accessible. The rapid spread of salt cedar has caused significant changes in the water relationships and ecology of the areas which it has invaded resulting in both adverse and beneficial effects. Salt cedar impacts were analyzed for twelve major areas. Under present conditions, salt cedar has adverse impacts in the areas of: water use, livestock forage, flood control, recreation, wildlife and plants; and beneficial impacts in the areas of: sedimentation, dove hunting, honeybees, windbreaks, soil stabilization and ornamental plants. A summary of the results presented in the economic account indicates that both a 50% and 90% program would be highly effective in terms of benefits and costs. Total annual benefits are estimated to be $22 million for the 50% program and from $40 to $62 million for the 90% program. Positive economic benefits occur in water use, livestock forage, flooding, and recreation; while negative economic benefits would accrue to sedimentation, dove hunting, honeybees and ornamentals. Environmentally, existing salt cedar infestations, under baseline conditions, adversely affect water use, forage, flood protection, recreation, 1 mammal species, 2 bird species and 28 native and threatened plant species. Positive impacts occur in sedimentation, dove populations, honeybees, soil stabilization and 2 bird species. Sociologically, under baseline conditions, salt cedar adversely impacts water use, forage, flood protection, sedimentation, recreation, ornamental landscaping, wildlife and plant life. Positive impacts are found in dove hunting, honeybees, windbreaks and soil stabilization. (Lantz-PTT)
W90-03818

MODELING THE EFFECT OF BRUSH CONTROL ON RANGELAND WATER YIELD.
Maryland Univ., College Park. Dept. of Agronomy.
M. R. Savabi, J. G. Arnold, C. W. Richardson, and J. H. Krishna.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 855-865, August 1989. 6 fig, 6 tab, 23 ref.

Descriptors: *Texas, *Water yield improvement, *Model studies, *Water demand, *Hydrologic models, Rangeland, Farmland, Brush control, Soil water, Comparison studies.

With the increase in water demand in Texas, attention has turned to improving water yield by brush control on rangeland watersheds. Several hydrologic models have been developed for either farmland or rangeland. However, none of the models were specifically developed to assess the impact of brush control on rangeland water yield. Yet, modeling the impact of brush control on water yield needs to be considered if alternative techniques are to be compared. Two models, Ekalaka Rangeland Hydrology and Yield Model (ERHYM-II) and Simulator for Water Resources on Rural Basins (SWRRB) were selected. The Soil Conservation Service curve number (SCS-CN) method is used in both models to predict surface runoff from each rainfall event. The major differences between the ERHYM-II and SWRRB models are the evapotranspiration, soil water routing, and plant growth components. The models were evaluated on brush-dominated and chemically and mechanically brush-controlled range watersheds in Texas. Results indicated that both models were capable of simulating soil water and water yield from brush dominated and chemically brush-controlled range watersheds. The models were not able to predict water yield from the mechanically brush-controlled (root plowed) watershed with acceptable accuracy. The depressions that were caused by root plowing stored surface runoff and reduced water yield from the watershed. Information about the size of depressions was not available for further model evaluation. (Author's abstract)
W90-04183

APPLIED ATMOSPHERIC RESOURCES RESEARCH PROGRAM IN THAILAND.
Bureau of Reclamation, Denver, CO. Div. of Research and Lab. Services.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-235402. Price codes: A07 in paper copy, A01 in microfiche Report No. R-89-10, August 1989. 134p, 2 fig, 8 tab, 27 ref, 2 append. Agency for International Development Contract ANE-0337-P-IZ-8021-00.

Descriptors: *Atmospheric water, *Thailand, *Water resources management, *Cloud seeding, *Weather modification, Cloud physics, Field tests, Research priorities, Precipitation, Rainfall, Radar, Model studies.

The Royal Thai Government requested assistance of the US Agency for International Development for the development and implementation of a more comprehensive scientific approach to the design, operation, and evaluation of Thailand's weather modification program. Upon visiting Thailand, a team of American scientists recommended a 5-yr developmental program to improve Thai technical capabilities through training, additional equipment, and a demonstration cloud seeding project. A core training course was conducted in Thailand in early 1988. A study of the scientific concepts underlying the Thailand program was performed using one-, two-, and three-dimensional cloud models, some adjusted to simulate cloud seeding to test various cloud treatment scenarios for the demonstration program. This program will test for an increase in rainfall from: (1) warm clouds seeded with hygroscopic agents, and (2) cold clouds seeded for dynamic effects with glaciogenic materials. Cloud model runs produced encouraging results for both cloud types, so a preliminary design has been developed for the demonstration project. The field program will be conducted in the Nam Mae Tun River Watershed of western Thailand. Field equipment and support will include cloud seeding aircraft, a 10-cm Doppler radar with dual polarization, an operations center for weather forecasting and monitoring, and a rain gauge network. A randomized crossover design is proposed with the experimental unit, the assemblage of clouds affecting a randomly selected target area over 3 hrs. The primary response variable is rainfall measured by rain-gauge adjusted radar. Analyses indicate that rainfall occurs on about 90 days/wet season and, if seeding yields 10% increases, about 90 experimental units are required per stratification to achieve a 90% probability of detection at a significance level of 0.05. Given equal numbers of warm and cold cloud units and typical operations problems and weather variability at least four seasons of field experimentation are required. (Author's abstract)
W90-04260

3C. Use Of Water Of Impaired Quality

RESEARCH ON THE HEALTH IMPLICATIONS OF THE USE OF RECYCLED WATER IN SOUTH AFRICA.
Water Research Commission, Pretoria (South Africa).
W. H. J. Hattingh, and D. E. Bourne.
South African Medical Journal SAMJEJ, Vol. 76, No. 1, p 7-10, July 1 1989. 37 ref.

Descriptors: *Public health, *South Africa, *Water scarcity, *Reclaimed water, *Potable water, *Water reuse, Water supply, Epidemiology, Drinking water, Wastewater renovation.

South Africa has an inadequate and unreliable supply of water. It is expected that water resources will be a limiting factor to development by the year 2020. Reclamation and reuse of sewage effluent is one possible method of supplementing existing supplies. Windhoek has had direct supplementation of its water supply for over a decade. Guidelines for using recycled sewage as a source of potable water, along with South African studies on chemical, microbiological, and virological aspects of reclaimed water are reviewed. Epidemiological studies conducted in Windhoek by the Water Research Commission and the South African Institute for Medical Research emphasized the fact that the drinking water in Windhoek did not contribute to the occurrence of the acute effects of diarrheal diseases and viral hepatitis. It was concluded that, from a microbiological standpoint, the reclaimed water was safe to drink. The Cape Peninsula might be the first area in South Africa to consider the use of reclaimed water, since once all the existing known sources of potable water have been exploited, sources such as desalination of sea water and the reclamation of treat sewage effluents will have to be considered. The question of whether the presence of some chemical compounds in drinking water in the ng/L range is important when man is exposed to it over a lifespan of about 70 years poses a dilemma to the water scientist. It is believed that the medical profession will have to join hands with the water scientist to obtain answers to these questions and to set realistic goals for the quality of drinking water. (Friedmann-PTT)
W90-03925

PRODUCTION, COST, AND INCREASED SALINITY IN WATER.
Central Michigan Univ., Mount Pleasant. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W90-03981

DESIGN OF DILUTION JUNCTIONS FOR WATER QUALITY CONTROL.
Technion - Israel Inst. of Tech., Haifa. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 5F.
W90-03982

BORON CONTENT OF SOUTH AFRICAN SURFACE WATERS: PRELIMINARY ASSESSMENT FOR IRRIGATION.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 3F.
W90-03996

UTILIZATION AND TREATMENT OF THERMAL DISCHARGE BY THE ESTABLISHMENT OF A WETLANDS PLANT NURSERY.
Anne Arundel Community Coll., Arnold, MD.
M. S. Ailstock.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 719-726, 3 fig, 1 tab, 15 ref.

Descriptors: *Maryland, *Nurseries, *Thermal pollution, *Water reuse, *Land disposal, *Wastewater treatment, Biological wastewater treatment, Water pollution control, Macrophytes, Performance evaluation, Spartina, Heated water.

The Nevamar Corporation, in Odenton, Maryland, manufactures decorative building materials in a process that generates 284,000 L of heated water per hour. Permits for discharge of this water into the Severn River have lowered the acceptable discharge temperature to 32.2 C. As part of the permit process, a study was conducted of ways to improve holding pond cooling efficiency. Possibilities include increasing pond depth, surface area, and equalization and retention time as suitable modifications. These improvements were compatible with and would be optimized by a wetlands plant nursery, which is described here. Wetland plants can be grown in 4-L to 12-L containers placed in channels filled with gravel and receiving the heated water. The flow provides continuous irrigation and, with the exception of an occasional supplementary application of slow-release fertilizer, the plants are maintenance free. Availability of warm water greatly extends the growing season and significantly enhances belowground growth. Two wetlands projects have been installed with plants produced using this wetland nursery (Spartina spp. marshes, a 111 sq m area and a 610 m shoreline stabilization area requiring 25,000 plants). Numerous applications for the plants grown in this type of nursery suggest that the concept has wide potential application. (See also W90-04392) (Rochester-PTT)
W90-04464

3D. Conservation In Domestic and Municipal Use

ROLE OF WATER CONSERVATION AND ITS PROSPECTS FOR THE DEVELOPMENT OF URBAN WATER SUPPLY IN CHINA.
Ministry of Construction, Beijing (China). Dept. of Urban Construction.
S. Xutong.
Aqua AQUAAA, Vol. 38, No. 4, p 236-240, August 1989. 3 fig, 3 tab, 3 ref.

Descriptors: *China, *Water supply, *Management planning, *Water conservation, Developing countries, Water resources development, Urban areas, Technology transfer, Education, Public participation.

The current urban water supply situation in China is summarized and planning and implementation of conservation measures in the systems in more than 300 cities with more than 120 million residents are discussed. In the late 1960s, a shortage of water had arisen in China. The development of urban water supply may be divided into three stages: (1) the free, (2) the restricted, and (3) the reused. Great attention has been paid to urban conservation and many legal, administrative, economic, and technical measures have been adopted with increasing benefits. More than 200 administrative organizations have been established to deal with water supply through media propaganda and educational activities, establishing a water conservation management network, planned implementation of conservation, a flexible water price system to promote water saving, strict control of the exploitation of city groundwater, and speeding up the development of water-saving facilities. The development of new sources is not the answer to

China's water supply problems. Developing water reuse and conserving water must be the strategy. (Rochester-PTT)
W90-03965

OPTIMAL OPERATION OF WATER DISTRIBUTION SYSTEMS.
Texel Electronics, Tel-Aviv (Israel). Dept. of Real-Time Control for Water Systems.
For primary bibliographic entry see Field 5F.
W90-03976

WATER CONSERVATION SCENARIO FOR THE RESIDENTIAL AND INDUSTRIAL SECTORS IN CALIFORNIA: POTENTIAL SAVINGS OF WATER AND RELATED ENERGY.
Lawrence Berkeley Lab., CA. Energy and Environmental Div.
For primary bibliographic entry see Field 3E.
W90-04265

WATER CONSERVATION.
Pennsylvania State Univ., University Park. School of Forest Resources.
W. E. Sharpe.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 225-241, 1 tab, 26 ref.

Descriptors: *Urban hydrology, *Water pollution control, *Water conservation, *Domestic water, *Economic aspects, Energy, Water use, Pricing, Water demand, Water management, Public participation.

Methods of water conservation being advocated and used in domestic systems are compared. Conservation devices are more direct and effective than pricing and metering, as well as cost effective, acceptable to the user and inexpensive. Pricing alone will not be effective in achieving water conservation goals. Energy saving objectives have come to be as important as water conservation today. A California estimate is that if only 2% of households use the conservation devices, the energy saving alone will pay for giving the devices to all households. There is a need for better water budget data in municipal systems to show managers where the water is being used. Unaccounted for water is assumed to be system leakage although this may not be correct. Water conservation (reduced volume demand) in some systems is of less concern than reduction of peak hourly demand because of a desire or necessity to defer capitol investment in system enlargement. Energy supply and costs will set the trend in water pricing practice. Water utilities will follow the lead of energy utilities in rate structure changes. Most water system managers do not know the reliability of their water supplies and consequently they are unprepared for crises that occur. Public awareness education is a key responsibility of the system managers. A water conservation ethic may be useful even in wet periods of adequate supply to condition water users to more restricted use. (See also W90-04338) (Lantz-PTT)
W90-04362

3E. Conservation In Industry

ROLE OF WATER CONSERVATION AND ITS PROSPECTS FOR THE DEVELOPMENT OF URBAN WATER SUPPLY IN CHINA.
Ministry of Construction, Beijing (China). Dept. of Urban Construction.
For primary bibliographic entry see Field 3D.
W90-03965

HYDROPOWER OPTIMIZATION VIA SEQUENTIAL QUADRATIC PROGRAMMING.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
G. E. Diaz, and D. G. Fontane.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 715-734, November 1989. 6 fig, 1 tab, 22 ref, append.

Descriptors: *Argentina, *Hydroelectric power, *Reservoir operation, *Optimization, *Mathematical models, Hydrologic models, Programming, Mathematical equations, Sequential quadratic programming, Computers.

Optimal allocation of powerplant releases during peak demand periods carries an economic advantage in the operation of hydropower systems interconnected to large electrical networks. An alternative formulation is presented for determining release strategies when the objective is not maximizing total hydroelectric generation per se, but the economic benefit stemming from it. The proposed hydropower problem is formulated within the realm of concave programming without sacrificing realism in the formulation, thus yielding a nonlinear-concave objective function. A nonlinear mathematical programming technique, sequential quadratic programming (SQP), is used to solve the problem by successive solution of quadratic programming problems. The concave characteristic of the nonlinear objective function is fully exploited by SQP, which exhibits a rapid convergence to the global optimum. An expeditious procedure to formulate the hydropower problem under the SQP framework also is presented. The methodology was tested on an existing multi-reservoir hydropower system in Argentina. SQP proves very efficient to the extent that only a few minutes are necessary to solve the problem on a microcomputer. Furthermore, SQP is superior to sequential linear programming in the rate of convergency toward the optimal solution. (Author's abstract)
W90-03975

OPTIMAL OPERATION OF WATER DISTRIBUTION SYSTEMS.
Texel Electronics, Tel-Aviv (Israel). Dept. of Real-Time Control for Water Systems.
For primary bibliographic entry see Field 5F.
W90-03976

WATER CONSERVATION SCENARIO FOR THE RESIDENTIAL AND INDUSTRIAL SECTORS IN CALIFORNIA: POTENTIAL SAVINGS OF WATER AND RELATED ENERGY.
Lawrence Berkeley Lab., CA. Energy and Environmental Div.
P. Benenson.
Available from the National Technical Information Service, Springfield, VA 22161. Report No. LBL-6817, August 1977. 77p, 4 fig, 14 tab, 89 ref.

Descriptors: *Energy, *Water conservation, *Water use, *Municipal water, *Industrial water, *California, Laundering, Bathing, Electricity, Cooling water, Recycling, Hydrology, Energy sources, Population density, Heated water, Cost analysis, Water delivery, Water distribution, Model studies.

A residential and industrial water conservation scenario for California has been constructed in which water consumption has been disaggregated by residential end-use, industrial sector, and hydrologic study area. For each end-use and sector, water conservation measures have been delineated and their potential savings in terms of both water and attendant energy use have been estimated. In California, water is a major source of energy supply: in 1975, 25% of total electric energy was supplied by hydroelectric power. Water is also needed for powerplant cooling and fossil fuel extraction and refining. Energy is required to extract, convey, purify, and heat water prior to use, and to treat wastewater. Thus, water conservation results in water and energy savings. General conclusions drawn from these water/energy use estimations include: (1) Exterior water use, toilet flushing, and bathing are the largest residential water uses; conservation efforts applied to these end uses will result in the largest reductions in residential water consumption. (2) The highest per capita electricity consumption associated with water use occurs in the South Coastal hydrologic study area (HSA) where 57% of the State's population resides. (3) Of the four energy components considered, energy for water heating dominates the energy uses associated with water consumption. Potential natural gas savings are greater than potential electricity savings because gas hot water heaters are more prevalent than electric water heaters in California. (4) Bathing and laundry rank first and second for energy consumption among residential water uses because of the high volume of hot water used. (5) Industrial water consumption and the associated energy requirements for water delivery and distribution can be reduced by at least 19% and 23%, respectively. (6) The conservation measures that can be applied most immediately are housekeeping measures, some closed cycle cooling water reductions, and reuse of process water where extensive retrofitting of equipment is not required. (7) The centers of industrial water consumption are the South Coastal and San Francisco HSAs. (Lantz-PTT)
W90-04265

WATER USE FOR ELECTRIC POWER GENERATION.
Woodward-Clyde Consultants, San Francisco, CA.
D. M. Snyder, K. T. Mao, and R. D. Glynn.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 400-413, 6 fig, 2 tab, 11 ref.

Descriptors: *Water use, *Industrial water, *Electric powerplants, Cooling water, Social aspects, Technology, Environmental impact, Hydrology.

A major demand for water in the future will be for cooling steam-electric generating facilities needed to meet the nation's increasing demands for electric power. Plans to provide water for powerplant cooling must address economic, environmental, social, and legal considerations. Improved data from improved hydrologic forecasting will be vital in making difficult decisions regarding the allocation of water supplies for powerplant cooling as well as the siting and design of such facilities. As of 1975, approximately 75% of the coal and nuclear generating capacity in the U.S. was cooled using water from navigable waters for once-through cooling. The current industry trend, is toward evaporative cooling techniques due to EPA standards and diminishing water supplies. Alternative cooling technologies involve returning water to its source, either using storage ponds, spray ponds, or wet or dry cooling towers. Adverse environmental impacts from the use of surface water include thermal pollution, concentration of suspended or dissolved materials, or water vapor or droplets expelled from evaporative cooling systems may affect local downwind weather conditions. Regarding groundwater, if there is not sufficient recharge, it could deplete the stored supply, cause consolidation of the ground so that recharge is not possible, or may cause saline intrusion. Because of the conflicts between electric utilities and other competing water users, additional legislation may be needed. The Water Research Council has projected water requirements for steam-electric generation to increase by 7.5% per year between 1975 and 1985, and 5.1% per year from 1985 to 2000. Improved hydrologic data are important in the planning of steam-electric generating facilities to identify candidate power plant sites. (See also W90-04398) (Lantz-PTT)
W90-04337

3F. Conservation In Agriculture

CROP WATER USE.
Delta Branch Experiment Station, Stoneville, MS.
D. A. Pennington, L. Pringle, and G. Tupper.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 5-8. 5 fig, 1 tab.

Descriptors: *Mississippi, *Water use, *Irrigation practices, *Soil moisture retention, *Water requirements, *Crop production, Rainfall-runoff relationships, Agricultural hydrology, Irrigation engineer-

ing, Sprinkler irrigation, Soil types, Cotton, Transpiration.

Some of the research activities completed or underway by scientists of the Mississippi Agricultural and Forestry Experiment Station (MAFES), undertaken to improve the understanding of water resources in the region and efficient use of water, are reviewed. Research reviewed includes that which has focused on (1) surveys of water used by producers to sprinkler irrigate cotton, (2) the minimum water requirement of cotton on light textured soil, (3) the timing of the last sprinkler irrigation of cotton, (4) the reduction of cotton transpiration with growth regulators, (5) the variability of seasonal water use of rice during floods, (6) the potential for use of rainfall during permanent flood in rice, and (7) the scheduling of irrigations in a field with variable soil types. Recent research as conducted to determine the best approach for irrigating fields with variable soils. The research as conducted in a field that gradually changed from a fine-textured, heavy soil to a much lighter, coarser-textured soil. Results of the research did not indicate that irrigating a field based on the heavier soil or hot-spot needs will be the correct management program in all fields. Cotton can be over-irrigated. Also, the percent of the soil in the field that is heavy or light will be very important: a field that is 1% heavy soil and 99% light soil would benefit very little from the extra water needed by the heavy soil; a field that is 75% heavy soil and 25% light soil could benefit from the additional irrigations needed by the heavy soils. (See also W90-03708) (Friedmann-PTT)
W90-03710

FURROW IRRIGATION INFILTRATION AND EVALUATION.
Soil Conservation Service, Greenwood, MS.
J. D. Chism, and P. B. Rodrigue.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 40-43. 1 fig, 4 tab.

Descriptors: *Furrow irrigation, *Irrigation practices, *Infiltrometers, *Irrigation design, *Infiltration, *Soil water, *Irrigation water, Agricultural hydrology, Percolation, Irrigation, Irrigation engineering, Crop production, Cotton, Free water, Soil absorption capacity, Cracks, Absorption, Infiltration rate, Field tests, On-site investigations, Measuring instruments, Flow rates, Computer-aided design.

The most important factor to consider in furrow irrigation is the ability of the soil to absorb irrigation water. The rate and the amount of water the soil will absorb is important in designing irrigation systems. A flowing furrow infiltrometer was used to help develop information about how different soils respond to furrow irrigation. After initial setup and calibration, the infiltrometer was used to evaluate infiltration characteristics of a soil that was commonly irrigated using furrow methods. The first study site was a field in continuous cotton, having a soil with a moderately strong surface crust and many small cracks. During the infiltration test, water entered the soil and moved laterally through these small cracks into adjacent furrows. Indications were that the soil cracks extended to the depth of the plow pan approximately 12-14 in. in depth. The cracks qualitatively affected the results of the infiltration test. The second site was also in continuous cotton, with a soil of moderate surface crust with a few small cracks extending only a few mm into the soil. The traveling furrow infiltration data were collected over 1-3 hr time spans. In addition to the acquisitio of soil infiltration rates from the traveling furrow infiltration trailer, furrow evaluations were made on actual field applications to determine the actual performance characteristics of the system. After an evaluation is made, changes in management (furrow stream size, set time lengths, furrow length changes, etc.) can be recommended to improve irrigation accuracy. The system evaluated had rows of 1320 ft with a slope of .2/100 in the evaluation area. A furrow box was installed in the ground next to the gated pipe to measure the inflow stream size. The flow rate into the furrow was found to be 11.5 gpm (avg.) for a total of 19.2 hr. It was found that furrow evaluations will provide needed information for the computer design of irrigation systems in the future without the need for field evaluations. (See also W90-03708) (Friedmann-PTT)
W90-03715

1988 RICE WATER MANAGEMENT STUDY.
Soil Conservation Service, Greenwood, MS.
P. B. Rodrigue, and J. D. Chism.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 44-46. 1 fig, 2 tab.

Descriptors: *Water management, *Flood irrigation, *Water conservation, *Irrigation water, *Rice, *Irrigation design, *Irrigation efficiency, Management planning, Labor, Levees, Gates, Irrigation practices, Performance evaluation, Energy, Pumping, Conveyance structures, Fuel, Seepage loss, Runoff.

Water conservation practices were applied to two rice fields to determine their value. The practices were used to evaluate the effectiveness of conserving irrigation water and the energy required to pump it. These practices included narrower levee spacing to reduce the water impounded on the field and multiple side inlets to allow more beneficial use of rainfall and to provide for more efficient water delivery within the field. Using multiple side inlets allowed water to be provided to cuts individually or in groups of 2 to 3 rather than water being provided to the entire field through the top cut. The side lateral requires gates so the field, as a whole, requires more gates. Having more gates means more management and labor input. However, once the system is understood, management and labor requirements should be no more rigorous than present management systems. Instead, a lateral rigid plastic or collapsible irrigation pipe could be used to transport water to the cuts. A costly but easy to operate system would be an underground line with risers to several cuts. The objective is to apply only the water the cut needs and to allow freeboard for the utilization of rainfall. Each acre-inch of water saved is 27,000 gallons and requires 0.6 gallons of diesel fuel to pump. All of the study fields indicated that, with the exception of rainfall and seepage, rice farmers can virtually eliminate any runoff. If 4 inches of rainfall (or seepage loss) that would normally run off could be utilized on the fields, the pumping requirement could be reduced to 4 inches. (See also W90-03708) (Friedmann-PTT)
W90-03716

AGRICULTURAL PRACTICES: POLICY IMPLICATIONS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 5C.
W90-03779

ANNUAL REPORT 1988.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. 132 p.

Descriptors: *Developing countries, *Irrigation, *Drainage, *Water management, India, Pakistan, International Institute for Land Reclamation, Salinization, Brazil, Drainage systems, Public health, Mathematical models.

In 1988, the International Institute for Land Reclamation (ILRI) added the first computer program for personal computers to its list of publications: a mathematical model for basin irrigation called BASCAD (BAS=Basin, CAD-Computer-aided Design). Plans are underway to produce more of this type of publication (floppy disk with user's manual). Problems of irrigation management receive attention in the Annual Report in an article on the Tungabhadra Irrigation Pilot Project in India and in an article on the effectiveness and environmental impact of irrigation projects. An article on pipe drainage past and present also appears in the Annual Report. Reports on consultancy, training and research provided by the ILRI to developing countries are briefly described. ILRI staff cooperated with Brazilian authorities on the development of curricula for a program of regionally-oriented post-graduate training courses in land drainage, which will include case studies from the country's various problem areas. Publications and library and information services provided by the ILRI are listed. (See W90-03807 thru W90-03809) (Lantz-PTT)
W90-03806

PAST DEVELOPMENTS IN PIPE DRAINAGE AND ITS FUTURE PROSPECTS.
L. K. Smedema, and R. Van Aart.
IN: Annual Report 1988. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 8-17, 1 fig, 3 tab, 4 ref.

Descriptors: *History, *Developing countries, *Drainage, *Design standards, Agricultural hydrology, Drainage systems, Costs.

Since the late 18th century, when pipe drainage was introduced to control water tables in agricultural land, it has undergone remarkable developments, both in its design and in its technology. The developments in design were mostly the fruit of the gradual progress that was made in soil science, hydraulics, and hydrology during the 19th and 20th centuries. The technological developments were partly the result of other developments (e.g., the invention of new materials such as plastic) and partly a response to changing economic conditions. Changes in the agricultural context (e.g., mechanization, prices of agricultural products, agricultural policies) also had their effects on pipe drainage, at times promoting its development, at other times restraining it. Also important has been the continuous progress made in research on a wide range of agricultural production factors, making the drainage factor in many naturally waterlogged soils the minimum factor, thereby creating opportunities for its development. Developments that have been made in pipe drainage are reviewed, the factors that have influenced these developments are analyzed, and, the future prospects for pipe drainage in different parts of the world are discussed. (See also W90-03806) (Lantz-PTT)
W90-03807

EFFECTIVENESS AND ENVIRONMENTAL IMPACTS OF IRRIGATION PROJECTS: A REVIEW.
R. J. Oosterbaan.
IN: Annual Report 1988. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 18-34, 8 fig, 2 tab, 35 ref.

Descriptors: *Environmental effects, *Developing countries, *Irrigation programs, Economic aspects, Costs, Irrigation design, Evaluation.

Many new irrigation projects have disappointing results, from overestimates of benefits and underestimates of costs, losses, and damage, in the light of the ever-decreasing availability of land and water resources of good quality. The benefits are often less than expected because many projects are initiated, implemented, and operated 'top down', without regard for: farmers' needs and motivations; the discrepancy between national and rural targets; and the scarcity of well qualified and motivated managerial and technical staff. The direct costs are often higher than expected because: the direct costs are underestimated for reasons of financing; not all direct costs are recognized or foreseen; and the prevention of negative secondary effects requires unforeseen additional measures, which increase the direct costs. Despite the many disappointing results, irrigation can be a central component in producing food for the world's growing population and in sustaining the livelihood of farmers. For new irrigation schemes, the following

recommendations are made: (1) before investment decisions are taken, an independent, objective organization should review the technical design and the proposed farming system, both at feasibility and at implementational levels; (2) the socio-economic aspects, including informal legal issues as well as the needs and motivations of the population inside and outside the project, must be carefully reviewed, and the role and responsibilities of the farming community in the project should be assessed; (3) the environmental and ecological impacts of a project should be studied in detail, followed by proposals for project adjustment if necessary; (4) the managerial needs of the project have to be studied, including the monitoring and evaluation of project performance, operation, and maintenance, as well as the mode of financing the eventual remedial and compensatory measures; (5) the conclusions and recommendations of the socio-economic, environmental, and managerial studies must be integrated into the work of various independent organizations; and (5) the investment criteria have to be reconsidered with a view to sustainability. (See also W90-03806) (Lantz-PTT)
W90-03808

WATER DISTRIBUTION IN A SECONDARY IRRIGATION CANAL: RESULTS OF A MEASUREMENT PROGRAM.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
M. Jurriens, and V. Ramaiah.
IN: Annual Report 1988. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands. 1989. p 35-46, 9 fig, 5 tab, 6 ref.

Descriptors: *Irrigation programs, *India, *Water management, *Irrigation canals, Tungabhadra Water Management Project, Irrigation practices, Water demand.

The 1987 kharif (wet) season was the first season of a measuring program in the Tungabhadra Water Management Project in India. Consequently, some starting problems were met, resulting in some inaccurate and incomplete data. The total volume made available at the D36 inlet for the kharif season was about 60 million cubic meters (MCM), which was slightly below the theoretical allocation of 65 MCM. The average daily inlet flows from the Main Canal into the D36 canal were regularly much higher than target, at least in periods when sufficient flow was available in the Main Canal. At the more downstream locations, about halfway along the canal, canal flows are always below target. Evidently, offtakes through pipe outlets and minors on the first half of the canal are generally too high. The fact that many outlets are seriously leaking, so that they take a considerable flow even when the gates are closed, contributes to the situation. The measurement results illustrate that attempts are made to implement a system of canal section rotation. Nevertheless, considering the total picture, one does not get the impression that a canal rotation system is effective in pushing water to the tail of the canal. Closing and opening the outlets on a rotation section takes about the entire rotation period to be effectuated, and offtakes by the outlets are never zero as they are supposed to be. The result is that average offtakes are above target. (See also W90-03806) (Lantz-PTT)
W90-03809

CLASSIFICATION OF SALT-AFFECTED LAND IN AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2L.
W90-03813

BORON CONTENT OF SOUTH AFRICAN SURFACE WATERS: PRELIMINARY ASSESSMENT FOR IRRIGATION.
Department of Water Affairs, Pretoria (South Africa).
P. C. Reid, and E. Davies.
Water SA WASADV, Vol. 15, No. 4, p 261-264, October 1989. 1 fig, 2 tab, 3 ref.

Descriptors: *Water analysis, *Water quality, *Chemical analysis, *Boron, *South Africa, *Irrigation water, Spatial distribution, Regional analysis, Crops, Essential nutrients.

Boron, a naturally occurring constituent of surface and ground water, is an essential plant nutrient. At relatively low concentrations, boron becomes toxic to plant growth. To assess the boron status of South African waters, the Department of Water Affairs launched a long-term boron water quality assessment program in 1985. This program comprised analysis of water samples taken at 91 sites throughout South Africa. Results to date indicated that the boron concentration in South African surface waters varies between 0.02 and 0.33 mg/l. At these concentrations, even the most boron-sensitive crops can be grown without fear of boron toxicity. (Author's abstract)
W90-03996

COMPARISON OF TRACER MOBILITIES UNDER LABORATORY AND FIELD CONDITIONS.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-04107

STOCHASTIC MODEL TO EVALUATE RIPARIAN IRRIGATION EXPANSION IN THE EASTERN UNITED STATES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
D. Bosch, and G. Mustafa.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 945-952, October 1989. 1 fig, 4 tab, 22 ref.

Descriptors: *Water allocation, *Irrigation programs, *Riparian waters, *Irrigation water, *United States, *Model studies, Riparian rights, Surface water, Streamflow patterns, Soil types.

Irrigation has expanded in parts of the eastern United States. In some areas, the adjoining surface (riparian) water is the most economical source of irrigation water. Expanded demand for riparian water may lead to conflict among irrigators and other streamflow users. Accurate information on the potential for and impacts of riparian irrigation expansion is needed to decide if control of such expansion is necessary. A stochastic economic model to evaluate the impacts of potential irrigation expansion was developed. The model considers the soil, location, and land use characteristics of individual sites, as well as weather and streamflow patterns. The application of the model to an eastern Virginia watershed indicates that, with maximum potential expansion, water availability becomes limited and yields will be reduced in some years. As a result, the expected net returns from irrigation and the probability of breaking even on the investment are reduced substantially. The results suggest the need to consider regulation of surface water allocation for irrigation development in riparian watersheds. (Author's abstract)
W90-04198

EARLY MORNING CANOPY TEMPERATURES FOR EVALUATING WATER STRESS IN A WHEAT CROP.
San Diego State Univ., CA. Dept. of Geography.
A. S. Hope, and R. D. Jackson.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1009-1014, October 1989. 5 fig, 17 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Water stress, Irrigation requirements, Wheat, Temperature, Satellite technology, Comparison studies.

Several crop water stress indices were examined to determine their potential for use from a space-based system. Indices used included: (1) the 'stress degree day' (SDD); (2) the crop water stress index (CWSI); and (3) the temperature stress day (TSD). These indices were compared using data collected over a wheat crop grown under arid environmental conditions. Indices that required concurrent ground-based measurements were less adaptable than the simple difference between canopy temperatures of a field with unknown stress conditions and a similar crop known to be unstressed. The use of canopy temperature data collected by satellite to calculate TSD for wheat grown under arid conditions is feasible. The simple temperature difference between a stressed and a control field may be a viable technique to evaluate crop water stress using satellite data. (Author's abstract)
W90-04204

SOIL WATER CHARACTERISTICS OF TWO SOIL CATENAS IN ILLINOIS: IMPLICATIONS FOR IRRIGATION.
Michigan State Univ., East Lansing. Dept. of Geography.
R. J. Schaetzl, L. K. Hendrie, and S. W. Kirsch.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1023-1030, October 1989. 4 fig, 3 tab, 17 ref. Illinois Department of Energy and Natural Resources Project No. STILENRWR39-908.

Descriptors: *Illinois, *Irrigation efficiency, *Soil water, Soil types, Monitoring, Neutron scattering, Loess, Irrigation practices.

Soil water was monitored by neutron scattering in six soils, three each within two drainage catenas in east-central Illinois, over a 15-month time span. The prairie soils have formed in: (1) 76-152 cm of silt loam, eolian sediments (loess) over glacial till (Catlin-Flanagan-Drummer catena), and (2) loess greater than 152 cm in thickness (Tama-Ipava-Sable catena). The water content of these soils over the total time span and for wet and dry climatic subsets was characterized as an aid to potential irrigation decisions. Soils of the thin loess, C-F-D catena dried out to lower water contents and had greater soil water variability than did the thick loess soils. Under wet conditions, soil water contents in the two catenas were quite similar. It is suggested that yield-optimizing irrigation of the CFD soils may offset conditions of low soil water without creating adverse wetness in the poorly drained Drummer soils. The low water variability in the TIS soils, and the ample amount of soil water contained within the profile, combine to make them less suitable for 'economically intelligent' irrigation. Similar findings may hold true for other comparisons of irrigation/soil water relations on thick versus thin loess soils of the Midwest. (Author's abstract)
W90-04206

VALUING IRRIGATION WATER IN PUNJAB PROVINCE, PAKISTAN: A LINEAR PROGRAMMING APPROACH.
Agency for International Development, Islamabad (Pakistan).
For primary bibliographic entry see Field 6C.
W90-04211

IRRIGATION DEVELOPMENT AND MANAGEMENT ALTERNATIVES OF A DOLOMITE AQUIFER IN NORTHEASTERN ILLINOIS.
Illinois State Water Survey Div., Champaign.
S. J. Cravens, and S. D. Wilson.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1073-1083, October 1989. 7 fig, 9 ref.

Descriptors: *Irrigation design, *Geohydrology, *Illinois, *Water resources development, *Water use, Water scarcity, Irrigation effects, Water supply, Water storage, Aquifers.

Irrigation development of the dolomite aquifer in eastern Kankakee and northern Iroquois Counties, Illinois, is extensive and increasing. Interruptions of domestic supplies have been reported with increasing frequency during the 1980's. To address this issue, a regional assessment of the groundwater resources of the region was conducted in 1987 and 1988. Options for managing the dolomite aquifer were also investigated. Hydrogeology of the dolomite aquifer was determined using five aquifer tests. Transmissivity values of the dolomite aquifer ranged from 14,000 to 50,000 gpd/ft (168 to 600 cu m/m/day). Storage coefficients were between 0.0001 and 0.0002, within the range of a confined

(artesian) aquifer. Based on flow-net analyses, recharge of the dolomite aquifer ranged from 85,000 to 285,000 gpd/sq mi (124.4 to 417.0 cu m/day/sq km). Water levels of the dolomite aquifer were mapped during five periods in 1987 and 1988 by measuring up to 226 wells completed in the dolomite aquifer. Maximum regional water-level declines because of irrigation pumpage were 44 feet (13.4 m) in 1987 and 72 feet (21.9 m) during the drought of 1988. Based on groundwater use data, precipitation records, and hydrogeologic information, the magnitude of water-level declines can be attributed more to differing hydrogeologic conditions than to pumpage or climatic changes. Although record declines occurred during the drought of 1988, longterm depletion of the resource will only occur if irrigation development continues unregulated and drought conditions continue to prevail during successive years. (Author's abstract)
W90-04213

COMPUTER AIDED OPERATION OF IRRIGATION SYSTEMS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
G. N. Paudyal, and P. Somkiat.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 291-302, 4 fig, 3 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Mathematical models, *Data acquisition, *Computers, *Hydraulics, *Irrigation operation, Flow, Algorithms, Thailand.

A computer aided procedure has been developed to solve the problem of determining periodic (weekly) operation of an irrigation system consisting of open channels and various on-line and off-line structures to meet water demands, while satisfying operational constraints for the system. The procedure is based upon the representation of the gate operation of a general irrigation system as a hydraulic problem of nonuniform flow in open channels and through structures. A general data base also has been designed for storing, retrieving and updating information on canals, structures and flow characteristics. The algorithm, as coded in the interactive BASIC program, was applied to a portion of the Lam Nam Oon Irrigation Project in Thailand. The results were in good agreement with field observations. (See also W90-04274) (Hammond-PTT)
W90-04297

UTILIZATION AND TREATMENT OF THERMAL DISCHARGE BY THE ESTABLISHMENT OF A WETLANDS PLANT NURSERY.
Anne Arundel Community Coll., Arnold, MD.
For primary bibliographic entry see Field 3C.
W90-04464

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

INTERNATIONAL CONFERENCE ON RIVER REGIME.
For primary bibliographic entry see Field 2E.
W90-03626

REGIME ASPECTS OF FLOOD CONTROL CHANNELIZATION.
Northwest Hydraulic Consultants Ltd., Edmonton (Alberta).
C. R. Neill, and K. Yaremko.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. 317-329, 6 fig, 1 tab, 17 ref.

Descriptors: *Hydrological regime, *Regime streams, *Flood control, *Channeling, *Channel morphology, Case studies, Mississippi, Bangladesh, Alaska, New Mexico, Alberta, Flood peaks.

Channelization of natural streams causes various hydrologic and morphologic responses that are difficult to predict and treat. These include flood peak augmentation, profile degradation and aggradation, widening and deepening of cross-sections, and initiation of meandering or acceleration of meander shifting. A regime viewpoint is useful especially at the preliminary study stage for assessing the predominant characteristics of the stream and identifying likely responses, but quantitative application of the regime approach raises various problems especially with regard to channel planforms and bed-sediment transport. Problems in channel response and in applying the regime approach were illustrated with reference to embanked rivers in Bangladesh, a gravel river in Alaska, a channelized hill stream in Mississippi, a desert stream in New Mexico, and a channelized river in northern Alberta. Based on these case studies it was determined that: (1) a primary question in contemplating a flood control channelization is the potential for augmentation of flood peaks, both immediately and in the long term; (2) many instability response problems arise from the fact that channelization measures impose an increased or at best an unaltered slope where regime considerations require a reduced slope to suit augmented discharges and/or reduced resistance; (3) Lacey-type regime relationships derived from irrigation canals are not very useful for some classes of stream; and (4) regime relations of the Wallingford type appear promising for high-transport as well as low-transport channels, but more verification of field transport rates is required, as well as consideration of high wash loads and discontinuities in transport relations. (See also W90-03626) (Author's abstract)
W90-03651

INFLUENCE OF RIVER REGIME ON THE FLOOD MANAGEMENT OF SUKKUR BARRAGE, PAKISTAN.
For primary bibliographic entry see Field 5E.
W90-03652

APPLICATION OF BED STABILITY CRITERIA IN RIVERS WITH CONSECUTIVE RUN-OF-RIVER POWER PLANTS.
For primary bibliographic entry see Field 2E.
W90-03653

REGIME CHANGES IN THE CALEDON RIVER ASSOCIATED WITH SEDIMENT DEPOSITION UPSTREAM OF WELBEDACHT BARRAGE.
Pretoria Univ. (South Africa). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-03654

REGIME CHANGES IN THE CALEDON RIVER ASSOCIATED WITH WELBEDACHT BARRAGE: PHYSICAL MODEL, PROTOTYPE AND THEORETICAL CORRELATIONS.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 2E.
W90-03655

EFFECTS OF EXTENSIVE DREDGING ON THE RIVER REGIME.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2E.
W90-03656

REGIME THEORY AND ENVIRONMENTAL CHANGE-IRRECONCILABLE CONCEPTS.
University Coll. of Wales, Aberystwyth. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-03660

HISTORICAL ANALYSIS OF FLUVIAL HYDROSYSTEMS.
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03690

IMPACT OF 18TH AND 19TH CENTURY RIVER TRAINING WORKS: THREE CASE STUDIES FROM SWITZERLAND.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
For primary bibliographic entry see Field 2E.
W90-03691

HYDROLOGICAL CHANGES OF THE RHONE RIVER.
Grenoble-1 Univ. (France). Lab. de la Montagne Alpine.
For primary bibliographic entry see Field 2E.
W90-03693

HISTORICAL CHANGES OF THE GARONNE RIVER, SOUTHERN FRANCE.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
H. Decamps, M. Fortune, and F. Gazelle.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 249-267. 10 fig, 1 tab, 26 ref.

Descriptors: *History, *Paleohydrology, *Garonne River, *Geomorphology, *Flood plain management, *Ecological effects, Economic development, Flood protection, Navigation, Agricultural engineering, Industrial development, Urban areas, Rural areas, Forests, Flood plains, Cultivation, Water shortage, Riparian waters, Climates, France.

The Garonne is the third and the most southern of the large French Atlantic rivers. Man's impact on the Garonne has been progressive through the ages and has greatly changed the river over the last 300 years. Three stages have been distinguished: (1) changes to protect against flooding; (2) changes to aid navigation; and (3) developments in agriculture. These have all gradually modified the fluvial landscape and the changes have not been obscured by more recent industrial developments. Thus, this valley offers a useful model to study historical influences on the fluvial landscape in urban as well as in rural areas, the ecological consequences of the interactions between river dynamics, and man's activities related to the regional economic development of this essentially agricultural area. Two distinct periods of use of the river and its banks may be distinguished in the history of man's effect on the fluvial landscape: navigation during the 18th century and agriculture during the 19th century. These have been followed in the 20th century by a third period with intensification of agriculture, industrialization, and urbanization. As a result the conditions necessary for reversible trends in forest succession have not been lost on the floodplain but rather wooded areas have become fragmented, cultivated communities have replaced natural ones and there is an accentuation of water shortage during dry summers. This shortage is specific to large rivers in Southern Europe. Thus, a general model predicting the influence of man on the riparian dynamics of the fluvial landscape must pay more attention to the gradient of climatic conditions from north to south. (See also (W90-03689) (Fish-PTT)
W90-03704

ECOLOGICAL CHANGES OF THE FRENCH UPPER RHONE RIVER SINCE 1750.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
A. L. Roux, J. P. Bravard, C. Amoros, and G. Pautou.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 323-350. 10 fig, 32 ref.

Descriptors: *Ecological effects, *Paleohydrology, *River training, Channel morphology, History, Flora, Fauna, Maps, Channeling, Civil engineering, Navigation, Flood protection, Hydroelectric power, Discharge capacity, Dikes, Dams, Flow pattern, Sediment load, Vegetation, Invertebrates, Fish, Hydrologic models, France.

The flora and faunia composition of the Rhone River demonstrate that it can be designated a typical medio-European river. A range of data may be used, including cartographic, paleoecological faunistic and floristic evidence from relict channels, and documentary sources, to reconstruct the history of fluvial changes in the French Upper Rhone since 1750. Real impacts are due to civil engineering works implemented to promote and facilitate navigation, to protect towns and lands against floods and to produce hydroelectric energy. The main and direct consequences of harnessing the river have been channelization, constriction of the active alluvial valley, and discharge controls; these induced spatial, short-term and long-term impacts. The Rhone River changes exemplify the interactions between abiotic and biotic factors which may be discussed in a hierarchical framework: the dikes and the dams have produced first-order impacts on the flow regime and the sediment load, then changed the channel form, the substrate composition and the aquatic vegetation (second-order impacts), and at last invertebrates and fishes (third-order impacts). This pattern is valid in both the aquatic and terrestrial environments of the flood plain. By understanding the interaction of these complex processes, models can be developed to improve our understanding of how large alluvial rivers may change in the future. (See also (W90-03689) (Fish-PTT)
W90-03707

ANALYSIS OF 1987 FLOOD OF WEST MEMPHIS, ARKANSAS.
Memphis State Univ., TN. Dept. of Geography and Planning.
For primary bibliographic entry see Field 2E.
W90-03720

GROUNDWATER EXTRACTION TRENDS IN FOREST AND LAMAR COUNTIES, MISSISSIPPI.
University of Southern Mississippi, Hattiesburg. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03724

PRELIMINARY STEADY-STATE SIMULATION OF GROUNDWATER FLOW IN HINDS, MADISON, AND RANKIN COUNTIES, CENTRAL MISSISSIPPI.
Mississippi Bureau of Land and Water Resources, Jackson.
For primary bibliographic entry see Field 2F.
W90-03725

CATCHMENT MANAGEMENT IN AUSTRALIA IN THE 1980S.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 6A.
W90-03805

ECONOMIC ANALYSIS OF HARMFUL AND BENEFICIAL ASPECTS OF SALTCEDAR.
Great Western Research, Inc., Mesa, AZ.
For primary bibliographic entry see Field 3B.
W90-03818

EFFECT OF NUTRIENTS AND PESTICIDES APPLIED TO TURF ON THE QUALITY OF RUNOFF AND PERCOLATING WATER.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 5G.
W90-03894

1988 DROUGHT, BARGES, AND DIVERSION.
Illinois State Water Survey, Champaign. Midwestern Climate Center.
S. A. Changnon.
Bulletin of the American Meteorological Society BAMIAT, Vol. 70, No. 9, p 1092-1104, September 1989. 5 fig, 1 tab, 39 ref.

Descriptors: *Mississippi, *Drought, *Water deficit, *Drought effects, *Ships, Shipping industry, Economic impact, Barges, Dredging, Streamflow, Costs.

The impact of the 1988 U.S. drought, in terms of highly unusual late spring low streamflows, was analyzed. A notable, largely unexpected impact involved stoppages of barge traffic on the lower Mississippi River during June and July, a result of shallow areas produced by record low flows and shoaling. The low flows were a result of the unusually large areal extent of drought conditions across the Mississippi Basin, which comprises 40% of the continental U.S.. The deficient 1987-88 snowmelt (due to low winter snowfalls) and record low spring 1988 precipitation combined to produce the record low flows along much of the Mississippi River. Most responses to the drought came in a crisis mode and included concentrated dredging to open channels, government enforced reductions in barge loads, and in numbers of tow, tripled barge shipping rates, and shifts in transportation modes. The barge industry suffered a 20% income loss. The total losses to the barge industry coupled with higher costs for shipping were one billion dollars. The Illinois Central Railroad, which parallels the major blocked waterways, used a climate prediction to anticipate the low flows 3 months in advance. They leased additional cars to help handle the increased shipments transferred from barges and made a sizable profit. A response proposed by Illinois and shippers, a temporary increase in the water diverted from Lake Michigan to raise the river level, was met with strong objections by other lake states and Canada. The federal government declined the proposal, but the sizable controversy it engendered reflects the growing sensitivity to water resources issues in the Great Lakes Basin and also illustrates the problems to be expected from a drier future climate. This case study illustrates the value of using seasonal climate predictions of limited skill, and the need for better near real-time climatic data, including information about physical impacts of current climatic conditions. (Author's abstract)
W90-03936

REMOTE SENSING AND FULLY DISTRIBUTED MODELING FOR FLOOD FORECASTING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03980

LAKE BUHI: RESOLVING CONFLICTS IN A PHILIPPINE DEVELOPMENT PROJECT.
International Inst. for Environment and Development, London (England).
For primary bibliographic entry see Field 6G.
W90-04006

VALUE OF STREAMFLOW FORECASTING IN RESERVOIR OPERATION.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
A. P. Georgakakos.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 789-800, August 1989. 10 fig, 2 tab, 15 ref. USGS Grant 14-08-0001-G1416.

Descriptors: *Streamflow forecasting, *Reservoir operation, *Reservoirs, Savannah River, Nile River Basin, Simulation studies, Comparison studies.

Probabilistic streamflow forecasting can considerably improve reservoir operation but the benefits are system specific. The value of forecasting was evaluated for the Savannah River system, the High Aswan Dam, and the Equatorial Lake system. Some general observations are that improved streamflow forecasting enables the controller to: (1) increase energy output and reliability by raising the turbine hydraulic head and minimizing spillage; (2) mitigate drought repercussions by enhancing dependable water supply; and (3) reduce flood damages by avoiding excessive releases. These improvements may be rather attractive, particularly in reservoirs frequently operated under flood or drought conditions. The method of analysis employed was a system simulation under Extended Linear Quadratic Gaussian (ELQG) control. Comparisons with other control methods demonstrated the value of stochastic controllers with the ability to effectively handle reliability storage constraints. (Author's abstract)
W90-04176

NEW LOOK AT FLOOD RISK DETERMINATION.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04197

COMPARISON OF REGRESSION AND TIME-SERIES METHODS FOR SYNTHESIZING MISSING STREAMFLOW RECORDS.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 7C.
W90-04200

COMPARISON OF STREAMFLOW GENERATION MODELS FOR RESERVOIR CAPACITY-YIELD ANALYSIS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04201

PROCEEDINGS OF A SEMINAR ON FLOOD DAMAGE REDUCTION RECONNAISSANCE-PHASE STUDIES.
For primary bibliographic entry see Field 6F.
W90-04234

ANALYSIS OF TRAINING STRUCTURE DESIGNS IN SOUTHWEST PASS, MISSISSIPPI RIVER.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W90-04251

STORMWATER MANAGEMENT: PROCEDURES AND METHODS, A MANUAL OF BEST MANAGEMENT PRACTICES.
URS Co., Seattle, WA.
September 1977. 273 p. EPA Grant P-000091.

Descriptors: *Urban runoff, *Urban hydrology, *Urbanization, *Storm water, *Water management, *Handbooks, Management planning, Model studies, Urban drainage, Sedimentation, Flooding, Water quality, Erosion, Bank erosion, Slope stability, Administrative regulations.

The problems caused by urbanization are obviously many. Those of particular concern, as indicated by municipal engineers and planners are the following: streambank erosion, bluff and slope stability, sedimentation, flooding, general water quality degradation, and elimination of fish and other life from many streams. In addition, it has been indicated that many waterfowl have been killed by oil and highway drainage. A final issue which awaits resolution is that of drainage problems which exist between private individuals. The goal of public works officials is to provide consistent, sound guidance to developers so that the public's interests are protected and concerns satisfactorily addressed before, during, and after development. The intent of this Manual is to provide the public works officials and developers with the detailed guidance necessary to comply with the applicable urban drainage ordinances and policies, and to meet community goals regarding drainage management by means of sound preventive practices. Furthermore,

the use of the manual should facilitate prompt, equitable, and consistent processing of development permit applications. Following an introductory chapter and a chapter on how to use this manual, chapter 3 relates management practices to problems and provides a mechanism for selecting the most appropriate combination of practices for a given site. Chapter 4 outlines the permit application and drainage plan review process required by the Model Urban Drainage Ordinance, and discusses the interaction of Best Management Practices, Comprehensive Drainage Plans, and Technical and Administrative Procedures Manuals relative to the ordinance. (Lantz-PTT)
W90-04267

FLOOD HYDROGRAPH AND PEAK FLOW FREQUENCY ANALYSIS.
Hydrologic Engineering Center, Davis, CA.
A. D. Feldman.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 1-19, 4 fig, 1 tab, 37 ref.

Descriptors: *Flood hydrographs, *Flood peak, *Flood frequency, *Flood plain management, Frequency analysis, Streamflow, Statistical models, Statistical methods, Watershed management, Forecasting, Projections, Floods, Flooding.

There are numerous techniques for predicting peak flood discharges/volumes of prescribed frequencies. Statistical and empirical flood peak estimation techniques may be good for small areas where river routing/storage effects are not significant. For larger watersheds and studies requiring analysis of alternative flood control/watershed management procedures, the watershed simulation model is the best tool. A hybrid approach using a simple continuous model to identify significant events and a single event model to analyze those events in detail is a promising method of analysis. Watershed models are tending to become more directly based on readily measurable geographic parameters. The need for continuous accounting of soil moisture conditions would appear to be less necessary as one becomes better able to predict watershed model parameters from direct geographic meteorologic measurements. With this capability, single event models theoretically could be easily started for any event in question. Geographic information systems and utility programs to compute automatically the watershed model parameters are a promising technology for comprehensive river basin studies. This technique is particularly powerful in analyzing many land use and watershed and flood damage reduction management alternatives. If one uses a subjective measure of flood severity, such as general public inconvenience, then projects may be sized by methods which are not dependent on a true estimate of a flood frequency. This is generally the case in urban storm sewer design. If an objective estimate of expected economic damage is to be the design criterium, then realistic flood frequencies must be computed. Projects based on specific flood frequencies, say the 100-year flood of the flood insurance studies, would require consistent, but not necessarily precise, estimates of flood frequencies. In that case, insurance premiums could be adjusted, as actuarial experience indicates, to make the project viable. The landowners, however, would argue for the use of a precise frequency. (See also W90-04308) (Lantz-PTT)
W90-04309

DECISION MAKING AND THE COST OF IGNORANCE.
Engineering Decision Analysis Co., Inc., Palo Alto, CA.
For primary bibliographic entry see Field 6A.
W90-04313

HYDROLOGIC UNCERTAINTY AND PROJECT BENEFITS.
Bureau of Reclamation, Sacramento, CA. Mid-Pacific Regional Office.
For primary bibliographic entry see Field 7C.
W90-04314

MYTHS AND USES OF HYDROMETEOROLOGY IN FORECASTING.
Miami Univ., Oxford, OH. Inst. of Environmental Sciences.
For primary bibliographic entry see Field 6A.
W90-04316

BENEFITS OF UNCERTAINTY: PROBABILITY IN SHORT AND LONG TERM HYDROLOGIC FORECASTING.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-04318

PRECIPITATION FORECASTING AT A NATIONAL CENTER.
National Meteorological Center, Camp Springs, MD. Quantitative Precipitation Branch.
For primary bibliographic entry see Field 7C.
W90-04320

WATER SUPPLY FORECASTING IN CALIFORNIA--1976-78.
California State Dept. of Water Resources, Sacramento. Snow Surveys Branch.
For primary bibliographic entry see Field 7B.
W90-04326

CHANGING NEEDS IN URBAN FLOOD FORECASTING.
Urban Drainage and Flood Control District, Denver, CO.
For primary bibliographic entry see Field 2E.
W90-04327

FLOOD PLAIN MANAGEMENT NEEDS.
Office of the Chief of Engineers (Army), Washington, DC. Flood Plain Management Services Branch.
For primary bibliographic entry see Field 2E.
W90-04330

MAINTENANCE OF INSTREAM FLOWS.
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 2E.
W90-04351

LOCAL CONTROL OF FLOOD DAMAGE.
North Carolina Univ. at Chapel Hill. Dept. of City and Regional Planning.
D. H. Moreau.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 287-297, 2 fig, 3 ref.

Descriptors: *Flood-control storage, *Urban hydrology, *Water pollution control, *Flood control, *Flood damage, *Storm water, Flood plain management, Nonpoint pollution sources, Erosion control, Detention reservoirs, Sedimentation.

Storm water management was examined with respect to four basic areas of concern: control of drainage as a service to landowners on or near individual parcels of land; downstream flood control in flood plains along major receiving streams; control of nonpoint pollutants transported by storm water; and control of soil erosion and sedimentation. Caution is advised with the use of detention storage basins; when they are used in tributary watersheds for peak flow reduction, their effects are attenuated within relatively short distances downstream. Only if they are sized to retain all of the runoff for relatively long detention times can they contribute much to downstream flood reduction. Indiscriminant use of such facilities could actually aggravate downstream conditions by retarding hydrographs from tributaries so that they coincided with those of other tributaries on the receiving stream. They should be used only with careful engineering analysis based on site-specific information. (See also W90-04338) (Lantz-PTT)
W90-04367

CULVERT DESIGN AND CHANNEL EROSION.
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W90-04368

DEVELOPMENT OF AN URBAN RUNOFF TREATMENT WETLANDS IN FREMONT, CALIFORNIA.
Bowling Green State Univ., OH. Environmental Health Program.
For primary bibliographic entry see Field 5D.
W90-04458

CONTROL OF ARMYWORM, SIMYRA HENRICI (LEPIDOPTERA: NOCTUIDAE), ON CATTAIL PLANTINGS IN ACID DRAINAGE TREATMENT WETLANDS AT WIDOWS CREEK STEAM-ELECTRIC PLANT.
Tennessee Valley Authority, Muscle Shoals, AL. Vector and Plant Management Program.
For primary bibliographic entry see Field 5D.
W90-04476

4B. Groundwater Management

GROUND-WATER LEVELS IN THE ALLUVIAL AQUIFER AT LOUISVILLE, KENTUCKY, 1987-88.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03873

HYDROGEOLOGICAL AND HYDROGEOCHEMICAL CHARACTERIZATION AND IMPLICATIONS FOR CONSUMPTIVE GROUNDWATER USE OF A LARGE GLACIAL-DRIFT AQUIFER SYSTEM IN SOUTHWEST MICHIGAN.
Western Michigan Univ., Kalamazoo. Center for Water Research.
For primary bibliographic entry see Field 2A.
W90-03891

GROUND WATER RESOURCES OF THE TAURANGA GROUP SEDIMENTS IN THE HAMILTON BASIN, NORTH ISLAND, NEW ZEALAND.
Waikato Catchment Board, Hamilton (New Zealand). Resource Hydrology Unit.
For primary bibliographic entry see Field 2F.
W90-04130

LEGAL AUTHORITY TO PROTECT GROUNDWATER IN VIRGINIA.
For primary bibliographic entry see Field 6E.
W90-04232

GROUNDWATER DATA ACQUISITION AND PROCESSING AT TWO RECHARGE DAMS.
King Suud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
U. Sendil, A. S. Al-Turbak, and F. F. Al-Muttair.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 329-339, 5 fig, 8 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Groundwater management, *Artificial recharge, *Data acquisition, *Data processing, *Computers, *Mathematical models, Hydrologic budget, Floodwater, Meteorological data collections, Dams, Aquifers, Well data, Developing countries, Saudi Arabia.

Groundwater studies involving artificial recharge from dammed wadis require collection and processing of large amounts of data and extensive field work. Such data are not readily available in developing countries. After a survey of about 35 recharge dams in Central Saudi Arabia, two sites were selected with the aim of estimating recharge volumes from flood waters. Four observation wells were drilled and instrumented at each dam site for monitoring the water levels in the aquifer, and a meteorological station was established on each site. A stilling well also was installed on the dam to make continuous recording of the reservoir water level. All the collected information was stored in a computerized data base system. A computerized water balance model for a dam-reservoir system also has been developed. (See also W90-04274) (Hammond-PTT)
W90-04300

GROUNDWATER MANAGEMENT.
Layne Western Co., Norfolk, VA.
R. R. Peters.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 219-224.

Descriptors: *Conjunctive use, *Urban areas, *Urban hydrology, *Water pollution control, *Groundwater management, *Water supply, Public participation, Groundwater recharge, Groundwater budget, Groundwater quality, Water conservation, Water yield, Water use.

Conjunctive use of groundwater and surface water is an imperative where neither surface nor groundwater supply is sufficient by itself. Large volumes of groundwater are available in some regions. Management may include groundwater recharge for storage during wet years and conjunctive withdrawal in dry years. 'Safe yield' of an aquifer is difficult to determine and seldom accurately determined by managers/planners because they lack adequate physical data. Control of groundwater recharge sites is essential to protect both the amount and quality of recharge. This may become a land use regulation issue, especially in metropolitan areas. Smaller water supply organizations lack reliable estimates of 'dry year' supply--they are unable to plan for the contingency. Water conservation (demand reduction) measures can be effective for small systems as well as large--pricing, metering, retrofit conservation devices are examples. Energy supply and cost has become a significant factor in planning and management of water supply systems. The social dimension is critical to success in planning or management of water supply systems. Citizen motivation, responsiveness to incentives or penalties, and preferences among options must be understood by both planner and manager. Political inertia tends to slow public water system adoption of new technologies, both in planning and management. Legal and institutional provisions will be needed to help small systems sharing the same groundwater aquifer resolve management conflicts. (See also W90-04338)(Lantz-PTT)
W90-04361

4C. Effects On Water Of Man's Non-Water Activities

ECOLOGICAL STUDIES IN THE MIDDLE REACH OF CHESAPEAKE BAY: CALVERT CLIFFS.
Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. 287 p. Edited by Kenneth L. Heck.

Descriptors: *Nuclear powerplants, *Ecological effects, *Chesapeake Bay, *Water pollution effects, *Ecosystems, *Estuaries, Calvert Cliffs Nuclear Power Plant, Biological studies, Species composition, Population dynamics, Zooplankton, Fish, Shellfish, Invertebrates.

In this book the major results and findings from studies conducted over more than a decade by scientists from The Academy of Natural Sciences of Philadelphia (ANSP) are discussed. These studies were designed to assess the potential effects that operation of the Calvert Cliffs Nuclear Power Plant (CCNPP) might have on the mid-portion of Chesapeake Bay. The approach taken was to study major biotic components of the system over an area and a time period within a sampling comparison of conditions between preoperational and operational periods within a sampling locality, and comparisons of conditions at reference sites with those at impact sites after plant operations began. Elements chosen for detailed study included: species composition and production rates of major primary producers; water chemistry; zooplankton, benthos and finfish abundance and species composition; the abundance and growth rates of commercially important shellfish (clams, oysters and blue crabs); and the colonization sequences of invertebrates on artificial substrates. Taken together, these data provide a major source of information on long-term patterns and trends along the western shore of the mid-Chesapeake Bay. The data base is sufficiently large to permit characterization of dominant physical, chemical and biological processes in the middle reach and it permits us to explore relationships between nutrient availability and primary production, between primary and secondary production and between climatic variation and biological response. Emphasis is placed on summarizing the results of these studies and discussing what can be learned from them about the workings of Chesapeake Bay and, by extension, other estuarine systems. Also, briefly summarized are the effects of CCNPP operations on the Bay ecosystem; references are provided for where more documentation can be found. In the concluding chapter, the general significance of these findings are evaluated, some pros and cons of carrying out long-term monitoring studies are considered, and some recommendations for future studies of impact in estuarine systems are provided. (See W90-03600 thru 90-03609) (Lantz-PTT)
W90-03599

GENERAL CHARACTERISTICS OF THE CHESAPEAKE BAY AND STUDY AREA.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 2L.
W90-03600

ZOOPLANKTON.
Computer Services Corp., Annapolis, MD.
For primary bibliographic entry see Field 2L.
W90-03602

EPIFAUNA.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 2L.
W90-03603

SHELLFISH.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 2L.
W90-03605

ENTRAINMENT STUDIES.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
K. G. Sellner, M. E. Kachur, and M. M. Olson.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 226-253, 5 fig, 7 tab, 42 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Cooling water, *Entrainment, *Phytoplankton, *Zooplankton, *Ecological effects, *Thermal pollution, *Chesapeake Bay, Oxygen, Calvert Cliffs Nuclear Power Plant, Seasonal variation, Water temperature, Oxygen, Productivity, Chlorophyll, Flagellates.

Passage of estuarine water and phytoplankton through the cooling system of the Calvert Cliffs Nuclear Power Plant (CCNPP) in the summer months of 1977-1981 resulted in frequent reductions of phytoplankton densities particularly during periods when flagellated taxa dominated total cell numbers. Phytoplankton productivity as oxygen evolution of 14-C uptake was even more susceptible to the effects of passing through the cooling system. Entrainment-induced reductions in chlorophyll were observed on only four occasions, however. Inhibition of productivity was observed during periods dominated by flagellated cells and generally occurred with ambient water temperature > or = 25 C. Results from track autoradiography employed in 1981 indicated that carbon fixation in the commonly observed flagellate Cryptomonas acuta was significantly depressed during July, August and September. In contrast, the dinoflagellate Prorocentrum minimum and the diatoms Cyclotella caspia and Thalassioneman nitzschiodes were not affected by entrainment. Although entrainment affects Cryptomonas and flagellate-dominated assemblages in the summer there are no detectable effects of powerplant operations on cell densities or productivity in flagellate-dominated waters in the vicinity of the powerplant. Transitory exposure of estuarine zooplankton to the elevated temperatures of CCNPP entrainment and discharge plumes was generally nonlethal. In the species selected for study the survival rate after entrainment was 65-100%. The effects of temperature, salinity and dissolved oxygen levels upon entrained organisms were also analyzed. (See also W90-03599) (Author's abstract)
W90-03607

IMPINGEMENT STUDIES.
Academy of Natural Sciences of Philadelphia, PA.
R. J. Horwitz.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 254-269, 5 tab, 14 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Trash racks, *Screens, *Fish, *Ecological effects, *Species diversity, *Chesapeake Bay, Calvert Cliffs Nuclear Power Plant, Estuaries, Crabs, Flounders, Herring, Anchovies, Silverside, Survival, Fishkill.

The number of fish collected from a nylon net placed in the screen wash discharge troughs at the Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2 are tabulated by species. The most common species (90% of the total) found in the impingement samples were Anchoa mitchilli, Leiostomus xanthurus, Trinectes maculatus, Brevoortia tyrannus and Micropogonias undulatus. Although several of the same species were dominant in both impingement and trawl samples, the impingement samples contained greater numbers of species from habitats poorly sampled by trawling. A number of typically freshwater and estuarine species were captured in impingement samples but not in trawl samples. Survival studies showed high survival rates among blue crabs, flounders, cyprinodontids, gobies and blennies. Herrings, anchovies and silversides typically showed intermediate rates of survival and perciforms ranged variable but generally lower survival rates. The impingement samples and survival estimates were used to estimate total impingement of fish and impingement mortality by CCNPP for the period 1975-1983. In general, impingement mortality was small relative to the mortality rates from commercial fishing. (See also W90-03599) (Author's abstract)
W90-03608

THERMAL AND OTHER DISCHARGE-RELATED EFFECTS ON THE BAY ECOSYSTEM.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
G. R. Abbe.
IN: Ecological Studies in the Middle Reach of Chesapeake Bay: Calvert Cliffs. Lecture Notes on Coastal and Estuarine Studies Vol. 23, Springer-Verlag, New York, 1987. p 270-275, 25 ref.

Descriptors: *Estuarine environment, *Nuclear powerplants, *Water pollution effects, *Heated water, *Scour, *Radioisotopes, Ecosystems, *Thermal pollution, *Chesapeake Bay, *Ecological effects, Calvert Cliffs Nuclear Power Plant, Cooling water, Fish, Water temperature, Ducks, Heavy metals, Public health.

The Calvert Cliffs Nuclear Power Plant has several effects on Chesapeake Bay resulting from its cooling water discharge. Bay water is heated 6.7 C as it passes through the condensers, but mixing is rapid and the area enclosed by the +2 C isotherm is only 0.34 sq km. Fish were attracted to the discharge area by warm water and food, and shellfish grew faster in the discharge area than elsewhere. The discharge area was also a haven for ducks in winter. The high velocity of the discharge (2.7 m/sec) scoured an area of bottom removing sediments and exposing hard clay; soft-sediment biota (infauna) were replaced by epifauna. Copper and nickel, released by corrosion of the copper-nickel alloy condenser tubes, are no longer of concern since those condensers were replaced by ones of stainless steel and titanium. Releases of radionuclides were small and uptake by routinely sampled commercial and noncommercial species was also small. Radionuclides of environmental significance were silver associated with oysters and cobalt associated with sediments. Releases posed no threat to the ecology of the area or to human health. (See also W90-03599) (Author's abstract)
W90-03609

NATURAL AND ANTHROPOGENIC DISTURBANCES AT THE ECOSYSTEM LEVEL.
Alaska Univ., Fairbanks. Inst. of Marine Science.
C. P. McRoy.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 329-344, 26 ref.

Descriptors: *Benthos, *Arctic zone, *Alaska, *Valdez, *Regulations, *Ecological effects, Salmon, Fisheries, Ecosystems, Organic matter, Cycling nutrients, Zooplankton, Benthic environment, Wastewater disposal.

Anthropogenic disturbances have had and continue to have an impact on the ecosystem of Port Valdez. Two important events, are the protection of sea otters by the 1911 International Fur Seal Treaty, and the establishment of a salmon hatchery in the port in 1983. These two events have substantially increased the benthic and pelagic predators in the port and are expected to exert controls on community structure and energy transfer. The intertidal and subtidal benthic communities were thoroughly disrupted by the events associated with the 1964 earthquake and must have been experiencing ecological succession since that time. Research and monitoring programs in Port Valdez have been inadequate for understanding the ecosystem level effects of the development of oil transfer facilities. The pelagic community, which constitutes up to 85% of the organic matter transfer was virtually ignored for much of the development period. No study tracked major ecosystem level processes such as nutrient cycling or zooplankton grazing during this period. The only solid data base that exists is focused on the benthic community structure. Two considerations appear to have influenced the decision to emphasize the benthos while largely ignoring the pelagic community. One consideration is the relative structural persistence and stability of the benthic compared to the pelagic community. Although it is clear that the pelagic community with its seasonal biomass is structurally ephemeral, it is not clear whether the quantity, quality and timing of the carbon transfer from the water column to the benthos is constant or variable from year to year. Until it is known whether the pelagic community is functionally stable, we will remain in a very weak position for ascribing changes in the benthic community to specific disturbance events. A second factor in de-emphasizing study of the pelagic community in Port Valdez was the general lack of appreciation of how dynamic, disturbed and variable this system is. The tacit assumption of a stable environmental baseline has encouraged a narrow monitoring focus on specific disturbances such as the treated ballast discharge without adequate consideration of possible synergistic interactions among disturbances. (See also W90-03610) (Lantz-PTT)
W90-03623

OIL WELL OPERATION/MAINTENANCE AND SALTWATER INTRUSION: POLICY IMPLICATIONS.
Cities Service Oil Co., Charleston, WV.
For primary bibliographic entry see Field 5B.
W90-03777

URBAN LAND USE PRACTICES: POLICY IMPLICATIONS.
American Inst. of Planners, Washington, DC.
For primary bibliographic entry see Field 5G.
W90-03780

DIATOMS OF BURRINJUCK RESERVOIR, NEW SOUTH WALES, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2H.
W90-03804

EFFECTS OF HIGHWAY RUNOFF ON WATER QUALITY OF TWO WETLANDS IN CENTRAL FLORIDA.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 5G.
W90-03874

PROGRESS REPORT ON THE GROUND-WATER, SURFACE-WATER, AND QUALITY-OF-WATER MONITORING PROGRAM, BLACK MESA AREA, NORTHEASTERN ARIZONA--1988-89.
Geological Survey, Flagstaff, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03883

HYDROLOGIC INFORMATION AND ANALYSES REQUIRED FOR MITIGATING HYDROLOGIC EFFECTS OF URBANIZATION.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W90-03896

REGRESSION MODELS FOR ESTIMATING URBAN STORM-RUNOFF QUALITY AND QUANTITY IN THE UNITED STATES.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-03904

IMPACT ON WATER SUPPLIES.
For primary bibliographic entry see Field 2B.
W90-03924

PRACTICAL SIMULATION OF SEDIMENT TRANSPORT IN URBAN RUNOFF.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-04022

MODELLING THE EFFECTS OF CLEARCUTTING ON RUNOFF--EXAMPLES FROM CENTRAL SWEDEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping. Hydrological and Oceanographical Research Section.
For primary bibliographic entry see Field 4D.
W90-04079

MAN'S IMPACT ON THE ECOSYSTEM OF THE BALTIC SEA: ENERGY FLOWS TODAY AND AT THE TURN OF THE CENTURY.
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 6G.
W90-04081

CLIMATE CHANGE AND INTERNATIONAL POLITICS: PROBLEMS FACING DEVELOPING COUNTRIES.
Pacific Inst. for Studies in Development, Environment, and Security, Berkeley, CA. Global Environment Program.
P. H. Gleick.
AMBIO AMBOCX, Vol. 18, No. 6, p 333-339, 1989. 4 fig, 4 tab, 39 ref.

Descriptors: *Global warming, *Greenhouse effect, *Temperature effects, Political aspects, Water supply, Water quality, International waters, International agreements, Climates.

Global climate changes caused by human activities have the potential to alter agricultural productivity, freshwater availability and quality, sea level, and many other factors of importance to society. Rising temperatures will increase the demand for water for urban and agricultural uses, and elevated temperatures will alter snowfall and snowmelt patterns. Changes in precipitation patterns will affect the timing and availability of freshwater runoff, increasing flood risks in some regions and drought frequencies and intensities in other regions. Warmer waters and altered flows could worsen existing water-quality problems. And the hydrological changes anticipated will greatly complicate operating and managing our present system of aqueducts, reservoirs, and dams that were designed for past climatic conditions, not future ones. In regions where water resources are widely shared, these physical effects will have important political implications. Although the principal responsibility for the production of greenhouse gases lies with the industrialized countries, some of the worst impacts will fall on developing counties least able to prevent or adapt to the changes. This characteristic, together with the long history of political frictions and disputes worsened by environmental stresses suggests that global climatic changes have the potential to exacerbate existing international tensions. (Mertz-PTT)
W90-04082

ENVIRONMENTAL AND ECONOMIC IMPLICATIONS OF RISING SEA LEVEL AND SUBSIDING DELTAS: THE NILE AND BENGAL EXAMPLES.
Woods Hole Oceanographic Institution, MA. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2J.
W90-04083

EXTENT AND HISTORICAL DEVELOPMENT OF THE DECLINE OF DUTCH SOFT WATERS.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5C.
W90-04112

EFFECTS OF SIMULATED CANOPY COVER AND ANIMAL DISTURBANCES ON RILL AND INTERRILL EROSION.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
For primary bibliographic entry see Field 2J.
W90-04175

LAND-USE AND WATER QUALITY RELATIONSHIPS IN THE GEORGES CREEK BASIN, MARYLAND.
Frostburg State Coll., MD. Dept. of Geography
D. W. Duckson.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 801-807, August 1989. 1 fig, 5 tab, 17 ref.

Descriptors: *Coal mining effects, *Network design, *Maryland, *Model studies, *Land use, Water quality control, Monitoring, Data acquisition, Data processing.

Models developed in Ohio to predict water quality conditions resulting from various land uses associated with the surface mining of coal are employed to ascertain their transferability to Maryland conditions. Discriminant analysis is employed to assess patterns of association between water quality and land use variables, and predictive models were then constructed with which to quantify changes in stream quality to be expected from the changing mosaic of upstream land uses in the Georges Creek basin of western Maryland. Data collected under procedures specified by the regulatory authority in Maryland may have accounted for the lack of statistically significant results from these models. Maryland sampling program protocols were too often changed while in progress or aborted altogether. While it is not possible to design a data collection program that is ideal for all objectives, a good design for a water quality monitoring program might try to monitor: (1) current ambient water quality levels; (2) major point sources; (3) selective 'typical' drainage subbasins intensively in order to understand basic relationships; (4) to assess compliance; and (5) to test hypotheses, develop standards, or advance the state-of-the-art instrumentation. (Author's abstract)
W90-04177

APPLICATION OF THE U.S.G.S. DIFFUSION HYDRODYNAMIC MODEL FOR URBAN FLOODPLAIN ANALYSIS.
Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 2E.
W90-04212

ECOLOGY OF ATLANTIC WHITE CEDAR WETLANDS: A COMMUNITY PROFILE.
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 2H.
W90-04255

ENERGY FROM THE WEST: IMPACT ANALYSIS REPORT. VOLUME I: INTRODUCTION AND SUMMARY.
Oklahoma Univ., Norman. Science and Public Policy Program.
Available from the National Technical Information Service, Springfield, VA 22161. Report No. EPA-600/7-79-082a, March 1979. 159p, 11 fig, 60 tab. EPA Contract 68-01-1916.

Descriptors: *Resources development, *North America, *Environmental impact statement, *Energy, *Environmental effects, Water pollution effects, Geothermal power, Natural gas, Oil industry, Uranium, New Mexico, Arizona, Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming, Coal mining effects, Oil shale, Water requirements, Water quality, Available water, Labor, Wastewater facilities, Effluents, Aquifers, Aquifer characteristics, Climates, Stabilization ponds.

This is the final impact analysis report of a three-year technology assessment of the development of six energy resources (coal, geothermal, natural gas, oil, oil shale, and uranium) in eight western states (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, Wyoming) during the period from the present to the year 2000. This, Volume I, describes the purpose of the study and summarizes the results and conclusions of the analysis. Chapter 1 introduces the 'Energy from the West' study and describes the general context within which energy resources development in the West will occur. Chapter 2 describes the analytical structure of the study and the energy technologies considered, while Chapter 3 presents a summary of the results of the analysis of impacts likely to occur when western energy resources are developed. Five factors that vary among technologies can significantly affect water impatcts: (1) water requirements; (2) labor intensity; (3) amount and composition of effluents from facilities and from energy-related population increases; (4) the disruption of aquifers; and (5) the design and operation of holding ponds for effluents from conversion facilities. Six locational factors can also signficantly affect these impacts: (1) water availability; (2) water quality; (3) coal characteristics; (4) climate; (5) aquifer characteristics; and (6) the capacity of municipal wastewater treatment facilities. (See also W78-00753) (Lantz-PTT)
W90-04256

FROM CROPLAND TO CONCRETE: THE URBANIZATION OF FARMLAND IN VIRGINIA.
Virginia Water Resources Research Center, Blacksburg.
M. S. Hrezo.
Virginia Water Resources Research Center Special Report No. 12, October 1980. 16p, 4 tab, 35 ref.

Descriptors: *Cultivated lands, *Urbanization, *Virginia, *Land use, *Water use, Zoning, Public policy, Social aspects, Taxes, History, Economic aspects, Forests, Planning, Property rights, Profit, Soil conservation, Information systems.

The conversion of agricultural land to nonagricultural uses raises several important issues in Virginia and in the nation as a whole. Cropland and open space loss pose the potential for a dimunition of the quality of life in the Commonwealth. Uncontrolled conversions necessitate the cultivation of less productive, more erodible acres which results in greater costs to both farmers and consumers and in difficulties in finding fresh foods where produce has to be transported long distances. Zoning policies need scrutiny. The effects of property and estate taxation and of the cost/profit squeeze also play important roles in decisions on whether to retain land in production or to dispose of it for development. Government policies may hasten the conversion of cropland to nonagricultural uses. Satisfactory resolution of this dilemma necesitates, in turn, consideration of the total spectrum of land use activities and their accomodation to the Commonwealth's twin policy goals of local initiative and increased farm profitability. If all land use requirements are respected, balanced, and provided for, there also will be room for the protection of agricultural and forestal lands. Planning may decrease individual flexibility somewhat, but Virginia can accomplish it without threatening either individual property rights or its own farm policy objectives. Before such planning can occur, however, all the parties involved need more information than is now available. Evaluation of and choices between competing land use proposals rest on an understanding of the capabilities of the natural resource base. The completion of the national Soil Conservation Service survey, new satellite mapping techniques, and, in Virginia, the VARIS project should help meet this need. VARIS (Virginia Resource Information System) would provide Virginia with accurate, up-to-date information on: (1) land use and land use shifts affecting production; (2) soils, land classification, and productivity; (3) soil temperature and moisture and other climatic or environmental factors affecting crop production; (4) water use; (5) socio-economic factors relating to resources; and (6) the impact of human activities on resources. (Lantz-PTT)
W90-04264

STORMWATER MANAGEMENT: PROCEDURES AND METHODS, A MANUAL OF BEST MANAGEMENT PRACTICES.
URS Co., Seattle, WA.
For primary bibliographic entry see Field 4A.
W90-04267

ENERGY FROM THE WEST: SUMMARY REPORT.
Oklahoma Univ., Norman. Science and Public Policy Program.
For primary bibliographic entry see Field 6D.
W90-04269

WASHINGTON, D.C.'S VANISHING SPRINGS AND WATERWAYS.
G. P. Williams.
IN: Geology, Hydrology and History of the Washington, D.C. Area. 1989. p 76-94, 3 fig, 1 tab, 49 ref.

Descriptors: *District of Columbia, *Springs, *Urbanization, Environmental effects, *Waterways, Sedimentation, Land reclamation, History, Canals, Harbors, Potomac River.

This paper traces the disappearance or reduction of the many prominent springs and waterways that existed in Washington, D.C., 200 years ago. The best known springs were the Smith Springs (now under the McMillan Reservoir), the Franklin Park Springs (13th and I Streets, NW), Gibson's Spring (15th and E Streets, NWE), Caffrey's Spring (Ninth and F Streets, NW) and the City Spring (C Street between four and One-Half and Sixth Streets, NW). Tiber Creek, flowing south to the Capitol and then westward along Constitution Avenue, joined the Potomac River at 17th Street and Constitution Avenue. In the early 1800's, the Constitution Avenue reach was made into a canal which was used by scows and steamboats up to about 1850. The canal was changed into a covered sewer in the 1870's, and the only remaining visible surface remnant is the lock-keeper's little stone house at 17th and Constitution Avenue, NW. Because of sedimentation problems and reclamation projects, Rock Creek, the Potomac River, and the Anacostia River are considerably narrower and shallower today than they were in colonial times. For example, the mouth of Rock Creek at one time was a wide, busy ship harbor, which Georgetown used for an extensive foreign trade, and the Potomac River shore originally extended to 17th and Constitution Avenue, NW. (See also W90-04271) (Author's abstract)
W90-04272

ENVIRONMENTAL INFORMATION FROM SEDIMENTS.
Geological Survey, Menlo Park, CA. Geologic Div.
For primary bibliographic entry see Field 6G.
W90-04321

CHANGING NEEDS IN URBAN FLOOD FORECASTING.
Urban Drainage and Flood Control District, Denver, CO.
For primary bibliographic entry see Field 2E.
W90-04327

PRACTICES AND PROBLEMS IN FLOOD PLAIN MANAGEMENT.
Urban Drainage and Flood Control District, Denver, CO.
For primary bibliographic entry see Field 6F.
W90-04331

NATURAL FLUCTUATIONS OF WATER QUALITY IN A HEADWATER STREAM.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
J. F. Nix.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 391-399, 4 fig, 1 tab, 7 ref.

Descriptors: *Fluctuations, *Water quality, *Headwaters, *Path of pollutants, *Chemical interactions, *Water resources development, Caddo River, Arkansas, DeGray Lake, Suspended solids, Dissolved solids, Phosphorus, Fecal coliforms.

The Caddo River of southwest Arkansas drains a heavily forested section of the Ouachita Mountains. The predominant rock types are shale and sandstone. In the downstream section of the watershed, the US Corps of Engineers operate a reservoir for flood control, power generation, recreation, and other purposes (DeGray Lake). Observations of short-term variations in both dissolved and suspended materials have been made on the Caddo River at a point near the headwaters of the reservoir and in DeGray lake. The results of portions of these observations are used to illustrate the dynamic nature of this stream system and the importance of such variations in determining the fundamental nature of the stream. Although peaking in discharge and concentrations of both total organic carbon (TOC) and dissolved organic carbon (DOC) do not coincide, higher concentrations are

definitely associated with periods of elevated flows. Observations of the concentration of fecal coliforms show that higher values occur prior to peak flows. The Caddo River, like many of the streams in the Ouachita Mountains and Ozark Mountains have strips of grazing land on alluvial deposits bordering the streams. Grazing throughout the watershed is heavy in this zone. If it is assumed that the origin of the fecal coliform is principally cattle in this zone, the presence of these indicator organisms may serve as a tracer for material originating from grazing lands. For the same reason, it would appear that the origin of phosphorus in the rivers is not limited to the grazing environment, even though the application of phosphate fertilizers is a common practice on the grazing lands. Comparison of the total phosphorus concentration and turbidity during storms demonstrates that phosphorus is being transported on sediment. These observations indicate that the chemical dynamics of a relatively undisturbed headwater stream are such that short-term events may dominate the transport of certain substances, particularly phosphorus. Although the origin of the phosphorus cannot be tied to a particular section of the watershed, sequential relationships of other water quality parameters during the response of the river to a storm event suggest that its primary source is not the grazing environment. (See also W90-04398) (Lantz-PTT)
W90-04336

WATER PROBLEMS OF URBANIZING AREAS.
Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. 348 p. Edited by William Whipple, Neil Grigg and Richard Lanyon.

Descriptors: *Urban hydrology, *Water pollution control, *Urbanization, *Conferences, *Water resources development, Water supply, Water demand, Water quality control, Flood control, Urban runoff, Water pollution control, Technology.

The conference grew out of continuing concern by various members of the Universities Council on Water Resources and of the Urban Water Resources Research Council, during 1977 that the water problems of urbanizing areas were not being given sufficient attention. Originally the conference was intended to give principal attention to water quality and environmental problems, covering other water problems primarily as interfaces. However, the sponsoring agencies urged broadening of the scope; and, accordingly, water supply and flood control problems also were given attention. Presentations were prepared under five very broad categories, as they apply to water problems of areas undergoing urbanization: (1) an overview of urban hydrology and it's problems; (2) water pollution technology; (3) water quality interfaces and institutional aspects; (4) water supply and flood control; and (5) a consultant's report. (See W90-04339 thru W90-04369)(Lantz-PTT)
W90-04331

PROBLEMS OF STORMWATER RUNOFF AND FLOOD MANAGEMENT.
Urban Drainage and Flood Control District, Denver, CO.
For primary bibliographic entry see Field 6F.
W90-04345

CORPS OF ENGINEERS URBAN STUDIES PROGRAM.
Corps of Engineers, Waltham, MA. Basin Management Branch.
For primary bibliographic entry see Field 6F.
W90-04346

POLLUTION FROM URBAN AND INDUSTRIAL RUNOFF AND INSTREAM VARIATIONS IN WATER QUALITY.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W90-04347

CONTROL OF URBAN RUNOFF AND NON-POINT SOURCE POLLUTION.
Massachusetts Univ., Amherst. Water Resources Research Center.
For primary bibliographic entry see Field 5G.
W90-04348

WATER QUALITY EFFECTS OF LAND USE MANAGEMENT AND VEGETATION.
Illinois State Dept. of Transportation, Chicago. Div. of Water Resources.
F. Kudrna.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 152-156.

Descriptors: *Urban hydrology, *Water pollution control, *Land use, *Water quality trends, *Water quality management, Flood plain management, Easements, Research priorities, Water quality.

For land use planning in general, water quality is only one of many socially/technically desirable objectives. No specific land use control element appears to be justifiable solely on water quality objectives alone. The effects and relationships that take place during the transition from one land use to another are particularly important and even less well understood than static land use water quality relationships. Specific land use controls in addition to flood plain zoning were discussed, with suggestions that stream corridors, buffer strips, 'green acres', or open space easements do generate significant water quality improvement. But, for the present, many of the possible benefits from such practices remain intuitive or unverified hypotheses in the eyes of opponents of comprehensive environmental land us planning. Research is needed under a wide range of well defined conditions to establish the impact on water quality of land being used under various land use control regimes. Because of this, the practicality of obtaining early, effective land use controls, such as flood plain zoning for purposes of particular water quality objectives at the local level, are questionable. The greatest need is to clearly identify and quantify land use--water quality relationships if local authorities are ever to be able to prepare and secure strong support to implement effective land use controls with water quality objectives. (See also W90-04338)(Lantz-PTT)
W90-04355

EFFECTS OF URBANIZATION ON STREAMS.
Turner, Collie and Braden, Inc., Houston, TX.
D. R. Van Sickle.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 259-270, 3 ref.

Descriptors: *Urban hydrology, *Water pollution control, *Urbanization, *Stream discharge, *Streamflow, *Land use, *Flooding, Prediction, Flood peak, Urban runoff.

Urbanization through changed land use results in the following: (1) reduced concentration times and percolation, with subsequent increased flood peaks and total flood runoff; (2) increased stream flooding and channel erosion; and (3) reduced low flows and groundwater recharge for water supply. In an effort to quantify these effects, many millions of dollars have been spent over the past fifteen or so years on extensive gaging networks, collection and analysis of data, and on the development and calibration of complex mathematical models to simulate the urban runoff process. Most of the analyses of urban runoff gaging data have determined that impervious cover, is the most significant variable, and the various equations or nomographs resulting from the USGS interpretive reports for the various study areas ordinarily use it as the only variable (other than drainage area and frequency). The prediction of the effects of urbanization on peak runoff rates varies widely. The USGS study for Dallas indicated an increase of only 25% with full urbanization, while the Charlotte, North Carolina study indicated increases of 100% to 150% (that is, urban rates were 200% to 250% of undeveloped rates). Variations of two orders of magnitude (25% to 2500%) are often found in the predicted effects of urbanization, for areas not differing radically in physical characteristics, a situation not calculated to inspire confidence in urban hydrology. The flood insurance program and some of the conditions which emanate from it, particularly land use controls and the use, of detention ponds to negate or minimize the effects of urbanization on peak runoff rates, will increasingly make obvious the lack of knowledge of the quantitative impact of urbanization. Despite these uncertainties, a practical degree of accuracy can be achieved in projecting the probable consequences of urbanization, in that within the range of reasonable confidence there usually is limited significant variance among projections. (See also W90-04338) (Lantz-PTT)
W90-04365

CONSULTANT'S REPORT: URBAN INTERESTS IN WATER RELATED RESEARCH.
Public Technology, Inc., Washington, DC.
R. L. Scullin.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 306-312, 2 tab.

Descriptors: *Urban hydrology, *Water pollution control, *Urbanization, *Water resources, Research priorities, Technology transfer, Urban hydrology.

Urban centers responding to a needs survey have assisted the Office of Water Research and Technology (OWRT), of the US Department of the Interior, in better understanding urban needs in water resources research. Urban populations of 10-50,000, 50-500,000, and 500,000+ have voiced their concerns not only on general research interests, but also on specific, well defined problem topics. At all population levels, water supply distribution and water pollution control strategies were identified as areas requiring a high level of research and development. Other areas cited by one or more of the population categories as needing more research include water supply treatment, water conservation, energy conservation, and public health effects associated with the water supply. The needs survey also has identified technological gaps at the local level which perhaps can be bridged with available technology from Federal water research programs. Public jurisdictions want to see less redundancy in water research and more technology transfer of applied research that addresses the urban needs in water resources. The OWRT Technology Transfer program is dedicated to providing these services. The needs survey also requested local governments to offer any comments they may have that would assist OWRT in gaining a broader perspective of local activities in urban water resources research. More than 120 comments were received and forwarded to OWRT. It is the intent of the OWRT to coordinate the survey findings with other Federal programs responsible for water research and development. This cooperative effort will enable the many Federal programs now involved in water resources to better understand the urban problems and to effectively address these urban needs through concerted water research programs. (See also W90-04338)(Lantz-PTT)
W90-04369

LAND USE EFFECTS ON GROUND WATER QUALITY IN CARBONATE ROCK TERRAIN.
Arkansas Univ., Fayetteville. Dept. of Geology.
K. F. Steele, and J. C. Adamski.
Arkansas Water Resources Research Center, University of Arkansas, Fayetteville, AR. June 1987. Publication No. 129. 71p. 18 fig, 11 tab, 35 ref.

Descriptors: *Groundwater quality, *Land use, *Carbonate rocks, *Nonpoint pollution sources,

•Water pollution sources, •Agricultural runoff, Aquifers, Chemical analysis, Bacterial analysis, Arkansas.

A control site with a natural setting and an experimental site with significant agriculture land use were studied in the Ozark Region of Arkansas in order to determine the effect of land use on water quality in a carbonate rock terrain. The vast majority of the two sites have the Boone Limestone exposed which combined with the underlying St. Joe is the major aquifer for drinking water in the area. The sites also are similar in terms of lineament patterns (number, length and orientation), soil, slope and vegetation. Ground water samples were collected primarily from springs during three seasons (late summer-early fall, winter and spring). All three seasonal collections exhibited statistically higher NO3 (2.31 versus 0.81 mg/L) and Cl (9.9 versus 2.7 mg/L) concentrations in the experimental site. During the winter and spring collections, the experimental site also exhibited statistically higher concentrations (0.5 to 3x) of PO4, SO4, Na, K and Ca. Heavy metals were analyzed in the winter samples; however, the differences between the two sites were small because the absolute values for the two sites were low. For example, the largest difference for a heavy metal was 19 microgram/L for Mn (12 versus 31 microgram/L). Bacteria determined from the spring season samples showed that the experimental site had significantly higher counts of fecal coliform (86 versus 0.4 colonies/100 mL) and fecal Streptococcus (39 versus 3 colonies/100 mL) types than the control site. Three springs were also sampled periodically following a rain event of 10 cm. Whereas levels of specific conductance, NO3, Ca and Na decreased in all three springs, PO4, K, SO4 and fecal coliform increased significantly, primarily in the two experimental springs. The increase of these parameters indicates that they are more available in the experimental area. Based on these results and elemental correlations, it appears that cattle manure, the spreading of chicken manure and commercial fertilizers, and septic tank effluent, individually or in combination, are affecting the water quality of the experimental site. However, most of the ground water samples meet EPA drinking water standards with the possible exception of bacteria. (Author's abstract)
W90-04491

CHEMICAL PROPERTIES OF SOILS AND STREAMS IN NATURAL AND DISTURBED FOREST ECOSYSTEMS IN THE OUACHITA MOUNTAINS.
Arkansas Univ. at Monticello. Dept. of Forest Resources.
For primary bibliographic entry see Field 2E.
W90-04494

4D. Watershed Protection

INVESTIGATION OF A SHORELINE ENHANCEMENT TECHNIQUE FOR WETLANDS IMPACT MITIGATION.
Georgia State Univ., Atlanta. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-03756

RESERVOIR SHORELINE EROSION AND REVEGETATION WORKSHOPS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
H. H. Allen, and R. L. Lazor.
Army Corps of Engineers Water Operations Technical Support Information Exchange Bulletin, Volume E-89-1, October 1989. 5p, 3 photos, 2 ref.

Descriptors: •Watershed management, •Reservoirs, •Erosion control, •Revegetation, Shoreline cover, Shore protection, Turbidity, Water quality, Workshops.

In 1987, the US Army Engineer Waterways Experiment Station began organizing and conducting a series of annual workshops for Corps of Engineer (CE) personnel. The objectives were to illustrate and explain impacts of shoreline erosion in CE reservoirs; identify probable causes of erosion; demonstrate means of measuring and analyzing bank erosion and recession; review traditional means of protecting shorelines; and describe alternative methods of controlling erosion using vegetation or a combination of vegetative and structural solutions. With proper planning, site preparation, appropriate plant establishment methods used at the right time, and postplanting monitoring and maintenance, reservoir shorelines can be vegetated to satisfy several objectives including shoreline erosion control. Revegetating reservoir shorelines can help prevent and control erosion, reduce turbidity and improve water quality, establish fisheries and wildlife habitat, and enhance reservoir esthetic values. Workshops on reservoir erosion control and revegetation will continue to provide innovative techniques to field personnel and draw upon others' experiences in controlling reservoir shoreline erosion. (Lantz-PTT)
W90-03760

LONG-TERM EFFECTIVENESS OF VEGETATIVE FILTER STRIPS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W90-03956

MODELLING THE EFFECTS OF CLEARCUTTING ON RUNOFF--EXAMPLES FROM CENTRAL SWEDEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping. Hydrological and Oceanographical Research Section.
M. Brandt, S. Bergstrom, and M. Gardelin.
AMBIO AMBOCX, Vol. 17, No. 5, p 307-313, 1988. 10 fig, 1 tab, 22 ref.

Descriptors: •Forest hydrology, •Clear-cutting, •Sweden, •Runoff, Seasonal variation, Logging, Forest management, Model studies.

A hydrological model (PULSE model) was used both as a reference and as a forecasting tool to study the effects of forest management on hydrology in central Sweden. Three small basins were monitored before and after clearcutting. Increased total runoff and more pronounced peak flows were observed. The model was recalibrated to post-harvest conditions, and the two sets of model parameters were used to simulate the hydrological effects of hypothetical partial cutting in a large basin. During spring, the location of the cuttings affected peak flows because of nonsynchronous snowmelt and time delays in the basin. In autumn, the location of cuttings had very little effect on the peak flow. The total effect on peak flow of a 10% clearcut in a large basin was considered small compared to the effects of extreme weather conditions. (Author's abstract)
W90-04079

ECONOMIC EFFECTS OF SOIL CONDITIONS ON FARM STRATEGIES TO REDUCE AGRICULTURAL POLLUTION.
Maryland Univ., College Park. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 5G.
W90-04179

SEDEC; A SEDIMENT ECONOMICS SIMULATION MODEL.
Illinois Univ. at Urbana-Champaign.
A. Bouzaher, S. Murley, G. Johnson, and J. Braden.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 197-208, 3 fig, 2 tab, 18 ref.

Descriptors: •Model studies, •Computer programs, •Computer-aided engineering, •Mathematical models, •Simulation analysis, •Computers, •Sediment control, •Sedimentation, •Economic yield, •Farm management, Cropland, Crop yield, Watersheds, Streams, Soil erosion, Deposition.

A model was designed to identify, at a watershed or basin level, efficient control strategies for reducing sediment deposition in stream channels originating from cropland. The SEDEC (sediment economics) model combines farm planning economics, including a function relating soil losses to crop yields, and a sediment delivery relationship. The model may be used to identify minimum payments needed to induce landowner indifference between unconstrained farming and optimal land management practices that attain a specified level of sediment reduction. At the watershed level, the model can identify a set of least-cost management practices to attain a constrained level of sediment deposition. Because the model is amenable to efficient implementation on a microcomputer, it represents a valuable analytical tool for directing sediment control measures in a decentralized manner. (See also W90-04274) (Author's abstract)
W90-04288

RELATIONSHIP OF WATER QUALITY TO AGRICULTURE AND TO EROSION.
Fairfax County Dept. of Environmental Management, VA.
D. E. Strickhouser.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 143-151.

Descriptors: •Urban hydrology, •Water pollution control, •Agriculture, •Land use, •Erosion control, •Water quality, Soil erosion, Water quality, Monitoring, Bank erosion, Urbanization, Surface runoff, Path of pollutants.

Because research has not yet produced clear and universally applicable relationships between soil erosion, soil erosion control practices, and water quality, there is a need to establish fully measured and evaluated relationships applicable to stream sedimentation, such as those contained in the universal soil loss equations which apply to erosion from fields. Research should be undertaken to improve and strengthen possible use of this, and similar quantifiable relationships for range and timber soils, and also to investigate possible applicability for specified urbanizing and urban conditions. Perhaps the most serious overall need is to develop accurate quantitative relationships between land use practices and soil erosion control practices in agricultural areas, paying particular attention to areas under irrigation and/or drainage regimes. Specific contributions to water quality degradation from agricultural practices involving use of agricultural chemicals need to be identified. Urbanization can produce increased and accelerated runoff from impervious surfaces. There is a need to investigate increased channel an bank erosion and monitor the pollutants entering streams. In some areas erosion control practices have been effective. However, the quantitative relationships and verifiable benefits have not been clearly identified. For both agricultural and urbanizing areas there is a strong agreement on the need for more complete identification of the source and magnitude of pollutants arising from various soil erosion sources. Success in securing effective cooperation and participation in soil erosion control practices has been variable. However, where strong local districts exist, good records of cooperation and erosion control are evident. Such success is vital, because of the need for effective coordination of a wide variety of affected public and private interests. (See also W90-04338)(Lantz-PTT)
W90-04354

CULVERT DESIGN AND CHANNEL EROSION.
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W90-04368

SOIL EROSION CONTROL: WATERWAY EMBANKMENTS. NOVEMBER 1986-JANUARY 1989 (CITATIONS FROM THE SELECTED

WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855365. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 91 p. Supersedes PB88-850763.

Descriptors: *Bibliographies, *Bank protection, *Erosion control, *Watershed management, *Bank erosion, Topography, Water currents, Land use, Weather, Retaining walls, Revegetation, Vegetation establishment, Literature review.

This bibliography contains 134 citations concerning the mechanisms of bank erosion and measures for erosion control. Land topography, river topography and currents, land use, weather factors, and waterway traffic are among the topics discussed. Retaining walls and vegetation renewal are considered as erosion control measures. Specific case studies are also included. One hundred thirty-four citations are new entries to the previous edition. (Author's abstract)
W90-04479

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

RESPIRATION-BASED EVALUATION OF NITRIFICATION INHIBITION USING ENRICHED NITROSOMONAS CULTURES.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03597

PLASMID PROFILE ANALYSIS OF FECAL COLIFORMS ISOLATED FROM NATURAL WATERS.
University of Southern Mississippi, Hattiesburg. Dept. of Chemistry.
J. A. Evans, N. P. D'mello, K. K. Hamilton, and R. D. Taylor.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 121-125. 3 fig, 1 tab, 12 ref.

Descriptors: *Pollutant identification, *Plasmids, *Coliforms, *Water quality, *Bacterial analysis, *Sewage bacteria, Bacteria, Natural waters, Outfall sewers, Performance evaluation, Comparison studies, Mississippi, Cluster analysis, Wastewater lagoons, Escherichia coli, Microbiological studies.

The plasmid profile analysis was evaluated for use in assessing the bacteriological quality of water. Coliforms were isolated above, below and at sewage outfalls in the Bouie and Leaf Rivers from sewage treatment lagoons near Hattiesburg, Mississippi. Plasmids were isolated from each coliform and characterized by size with agarose gel electrophoresis. Size profiles of the plasmids found at the various sites were compared. Plasmids were isolated from E. coli. Simple visual inspection of size patterns was not adequate to distinguish water known to be impacted by human derived coliforms from other waters. Attempts to use cluster analysis on the plasmid profiles did not yield any useful information. Comparison of plasmids by size groupings also did not reveal any overall trend in similarity to water directly impacted by sewage and downstream of the outfall. There was similarity in one important size grouping, as water impacted directly or, for the South Lagoon, indirectly had high values in the 0-9.9 Mdal range (from 40% to 52%). Above the sewage outfall, this group ranged from 27 to 38%. Comparison of plasmids grouped by number of plasmids per isolate yielded the finding that water impacted by sewage had the lowest percent of E. coli isolates without plasmids. The most significant finding is that a simple view of overall plasmids profiles cannot be used to assess water quality. (See also W90-03708) (Friedmann-PTT)
W90-03728

FISH AS SENTINELS OF ENVIRONMENTAL HEALTH.
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
R. A. Murchelano.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-139737. Price codes: A03 in paper copy, A01 in microfiche. NOAA Technical Memorandum NMFS-F/NEC-61, September 1988. 16p, 4 fig, 23 ref.

Descriptors: *Water pollution effects, *Boston Harbor, *Organic compounds, *Fish diseases, *Bioindicators, *Water pollution sources, Fisheries, Storm runoff, Municipal wastewater, Industrial wastewater, Flounders, Polychlorinated biphenyls, Aquatic environment, Environmental effects, Polycyclic aromatic hydrocarbons.

Boston Harbor, Massachusetts, is polluted by storm water runoff, municipal wastewater, and sewage sludge, as well as riverborne domestic and industrial pollutants, and introductions characteristic of and related to the sustained heavy commercial ship traffic in the port. Shallow areas of the inner harbor provide suitable spawning and nursery areas for winter flounder. The harbor contains large numbers of winter founder during most of the year and is virtually a sanctuary for the species since commercial fishing is prohibited. Recent disease surveys have shown that harbor winter flounder have a high prevalence of gross and microscopic hepatic lesions, including carcinomas. Although harbor sediments contain high concentrations of polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB), the evidence ascribing either one of these organic chemicals as a direct cause of the neoplastic lesions observed is circumstantial. As a case study, however, investigations as to the cause and prevalence of hepatic carcinoma in Boston Harbor winter flounder will attest to the utility of fish as sentinels of aquatic environmental health. (Author's abstract)
W90-03743

HANDBOOK OF ENVIRONMENTAL FATE AND EXPOSURE DATA FOR ORGANIC CHEMICALS.
Syracuse Research Corp., NY. Center for Chemical Hazard Assessment.
For primary bibliographic entry see Field 5B.
W90-03748

SUPERFUND EXPOSURE ASSESSMENT MANUAL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5B.
W90-03849

VIROLOGICAL STUDIES OF WATER FROM THE CAPE FLATS RECLAMATION PLANT.
Cape Town Univ. (South Africa). Dept. of Medical Microbiology.
M. Hodgkiss, J. W. Moodie, and W. H. J. Hattingh.
South African Medical Journal SAMJEJ, Vol. 76, No. 1, p 11-13, July 1 1989. 1 tab, 5 ref.

Descriptors: *Pollutant identification, *Water treatment, *Viruses, *Wastewater renovation, *Water quality, *Potable water, Water reuse, Reclaimed water, South Africa, Effluents, Effluent charges.

The virological quality of sewage effluent treated by a pilot reclamation plant on the Cape Flats, South Africa, was evaluated. Testing for rotavirus antigen was performed using immunofluorescence, a commercial rotazyme kit, rapid latex agglutination, polyacrylamide gel eclectrophoresis, RNA extraction, and hemagglutination. Samples taken from stages before carbon column purification were occasionally contaminated with reovirus type III. Four of the nine samples from carbon column effluent without chlorination were infected with either reovirus, poliovirus type II, rotavirus or coxsackie virus B5. Samples taken after sand filtration without carbon treatment and after all stages of treatment were uncontaminated. Although viruses were detected in samples taken from various points during reclamation before the final chlorination stage, it would appear that the final water from the reclamation plant is completely free of viral contamination and is as clear as domestic tap water; by virological standards, the final water from the Cape Flats reclamation plant is perfectly potable. (Friedmann-PTT)
W90-03926

STUDY OF THE DEPOSITIONAL ENVIRONMENTS OF THE DELTA OF THE EBRO BY MENAS OF MOLECULAR INDICATORS (ESTUDIO DE LOS AMBIENTES DEPOSICIONALES DEL DELTA DEL EBRO MEDIANTE INDICADORES MOLECULARES).
Centro de Investigacion y Desarrollo, Barcelona (Spain). Environmental Chemistry Dept.
J. Grimalt, and J. Albaiges.
Acta Geologica Hispanica, Vol. 21/22, No. 1, p 213-222, 1986/7. 5 fig, 1 tab, 28 ref. English summary.

Descriptors: *Deltas, *Path of pollutants, *Spain, *Fluvial deposits, *Deposition, *Sedimentation, *Sediment discharge, Organic compounds, Sterols, Lagoons, Molecular structure.

An inventory of molecular markers occurring in sediments from the Ebro Delta are presented. The inventory is to be used for the recognition of inputs of organic matter in this area and for the characterization of the corresponding depositional environments. The distribution of carboxylic acids and sterols define the preferential areas of deposition of continental inputs, which are generally euxinic. The occurrence of unsaturated alkane derivatives of diagenetic origin identify certain reductive environments in the lagoons. A new series of isoprenoid hydrocarbons, probably of algal origin, has also been identified. (Author's abstract)
W90-03928

CALIBRATION OF THE FRESHWATER MUSSEL, ELLIPTIO COMPLANATA, FOR QUANTITATIVE BIOMONITORING OF HEXACHLOROBENZENE AND OCTACHLOROSTYRENE IN AQUATIC SYSTEMS.
Windsor Univ. (Ontario). Great Lakes Inst.
R. W. Russell, and F. Gobas.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 576-582, October 1989. 1 fig, 13 ref.

Descriptors: *Monitoring, *Mussels, *Mollusks, *Calibrations, *Bioindicators, *Bioaccumulation, Water pollution effects, Organic compounds, Benzenes, Absorption, Calibrations, Styrene, Biochemistry.

A bioconcentration experiment was performed in the freshwater mussel Elliptio complanata for hexachlorobenzene and octachlrostyrene. The study demonstrates (1) the derivation of uptake and elimination rate constants from the experimental data, (2) the use of kinetic rate constants in establishing chemical specific relationships for chemical concentrations in the mussel and the water and (3) the role of these relationships in the planning and interpretation of biomonitoring studies. The initial concentrations of HCB (0.43 micrograms/L) and OCS (O.16 micrograms/L) in the water were below the earlier reported aqueous solubilities of 4.69 micrograms/L for HCB and 2.5 micrograms/L for OCS. This indicated that HCB and OCS were truly dissolved. After the mussels were added, the HCB and OCS concentrations in the water dropped rapidly due to the high initial uptake rates in the mussels. HCB and OCS concentrations in the water returned after 3 to 4 days to approximately half the initial water concentration and remained approximately constant throughout the remainder of the uptake period. At the end of the exposure period, a steady-state appeared to

have been reached for HCB but not for OCS. During the depuration phase, where the mussels were exposed to uncontaminated water, concentrations of HCB and OCS in the mussel declined logarithmically over time. Kinetically, it was determined that the length of time for which the mussels should be utilized to reach 95% of steady-state is minus ln 0.05/k2 or 3.0/k2. For HCB, this means that the mussels should be used for 17 days and for OCS, 43 days. When organisms are to be used as a tool to measure chemical concentrations in water, they need to be 'calibrated.' (Friedmann-PTT)
W90-03943

DETECTION OF MUTAGENICITY IN MUSSELS AND THEIR AMBIENT WATER.
Okayama Univ. (Japan). Dept. of Public Health.
S. Kira, H. Hayatsu, and M. Ogata.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 583-589, October 1989. 3 fig, 1 tab, 13 ref.

Descriptors: *Water pollution effects, *Mussels, *Mutagenicity, *Pollutant identification, *Bioindicators, *Mollusks, *Bioassay, Monitoring, Sampling, Animal tissues.

The mutagenicity of mussel bodies and that of their ambient water were measured, and the correlation between the mussel and water mutagenicities were investigated. Mutagenic compounds being detected were those adsorbable to blue cotton or blue rayon and that are extractable with a methanol-ammonia solution. The Ames assay was used for the detection of mutagenicity, with Salmonella typhimurium TA98 as the tester strain and with S9-mix for metabolic activation. Every sample of extract showed dose-dependent increase in the number of revertant colonies, and the numbers found for 0.8 g blue cotton were all more than twice the value for the solvent control. Thus, at all sites examined, the sea water contained mutagens. At every site, the mussel sample gave a greater number of revertant colonies than the water sample. The ratio between the activities of these two samples differ significantly among the sites, indicting that there is no obvious parallel between these mutagenic activities. The results show that mussels may be useful for detecting long-term mutagen pollution of seawater. (Friedmann-PTT)
W90-03944

BORON CONTENT OF SOUTH AFRICAN SURFACE WATERS: PRELIMINARY ASSESSMENT FOR IRRIGATION.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 3F.
W90-03996

IDENTIFICATION OF MUTAGENS IN DRINKING WATER.
Water Research Centre, Medmenham (England). Medmenham Lab.
H. Horth.
Aqua AQUAAA, Vol. 38, No. 2, p 80-100, April 1989. 14 fig, 10 tab, 53 ref.

Descriptors: *Pollutant identification, *Mutagens, *Drinking water, *Chlorination, Salmonella, Bioassay, Bacteria, Water analysis, Chlorinated hydrocarbons.

Mutagenicity is frequently detected in drinking water and may be a product of the reaction of chlorine with naturally occurring organics during drinking water disinfection. The production of mutagenicity resulting from chlorination of aqueous solutions of humic and fulvic acid, phenolic compounds, protein, peptides, amino acids, and structurally related compounds was investigated using the mutagenicity assay with Salmonella typhimurium strain Ta100. The relevance of these compounds as precursors of mutagenicity in drinking water treatment chlorination is discussed. Chlorination products were identified, including 2-phenyl-2,2-dichloroethanal, a product of the chlorination of phenylalanine. This was shown to be a bacterial mutagen. The highly potent bacterial mutagen, 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone, was detected in a concentrated extract of chlorinated tyrosine. This compound accounted for a substantial proportion of the mutagenic activity of the extract. Many chlorination products, including mutagens, were common to chlorinated humic, fulvic and amino acids, and chlorinated drinking water. (Author's abstract)
W90-04007

IMMUNOLOGICAL METHOD USING MONOCLONAL ANTIBODIES TO DETECT ENTEROBACTERIACEAE IN DRINKING WATER.
Stadtwerke Mainz A.G. (Germany, F.R.). Dept. of Water Supplies.
U. Obst, I. Hubner, M. Wecker, and D. Bitter-Suermann.
Aqua AQUAAA, Vol. 38, No. 2, p 136-42, April 1989. 5 fig, 1 tab, 12 ref.

Descriptors: *Immunoassay, *Water treatment, *Bacterial analysis, *Enterobacter, *Coliforms, *Pollutant identification, *Testing procedures, *Drinking water, Bioindicators, Water quality, Biochemical tests, Pathogenic bacteria.

Enterobacteriaceae and especially the group of coliform bacteria are the main indicators for the effectiveness of water treatment and for bacterial drinking water quality. The occurrence of such bacteria requires the immediate removal of the infection and an announcement to the health authorities which is regulated by law. Applying the common method that is part of the drinking water regulations, the coliform indicator needs 2 to 5 days until an ensured result can be obtained. In order to shorten this time, we developed a new immunological method using a monoclonal antibody against the whole group of Enterobacteriaceae including the pathogenic representatives. By this method and a preceding cultivation in a liquid medium, it is possible to detect the Enterobacteriaceae of a water sample within 1.5 days. Although the procedure of this rapid method is still not completely settled, the results show a significant correspondence to the conventional method, as well as a high specificity and sensitivity. The state of the procedure and recent experiences are described, and future development is discussed. (Author's abstract)
W90-04012

MODERN METHODS IN WATER ANALYSIS.
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
K. E. Quentin, and L. Weil.
Aqua AQUAAA, Vol. 38, No. 3, p 189-196, April 1989. 5 fig, 1 tab, 29 ref.

Descriptors: *Chemical analysis, *Water analysis, *Biochemical tests, *Pollutant identification, Chlorination, Water pollution, Pesticides, Herbicides, Heavy metals, Assay.

There are problems maintaining the quality of drinking water. During chlorination, volatile chlorinated hydrocarbons like trihalomethanes are formed. For bromoforms two different paths of formation are stated. There are two approaches to water analysis; pollutants are determined by description in group parameters (e.g. BOD, AOX), or single substances are identified, as is the case for pesticides. Classical analysis is performed by extraction, clean-up of extracts and quantification by gas chromatography or high-performance liquid chromatography. New biochemical methods are introduced for the determination of herbicides, including inhibition of cholinesterase, inhibition of the Hill reaction and enzyme immunoassay. Novel analytical problems caused by the complexing capacity of natural as well as man-made ligands also encouraged development of modern techniques for the determination of heavy metals. (Author's abstract)
W90-04016

MEMBRANE FATTY ACID AND VIRULENCE CHANGES IN THE VIABLE BUT NONCULTURABLE STATE OF VIBRIO VULNIFICUS.
North Carolina Univ. at Charlotte. Dept. of Biology.
K. Linder, and J. D. Oliver.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2837-2842, November 1989. 5 fig, 31 ref.

Descriptors: *Aquatic bacteria, *Bacterial analysis, *Escherichia coli, *Human pathogens, *Vibrio, Microbiological studies, Bioindicators, Coliforms, Population dynamics, Membranes, Estuarine environment, Pathogenic bacteria, Human pathogens.

Vibrio vulnificus is a human pathogen which has been isolated from nay marine and estuarine sources and can cause both fatal septicemia and serious wound infections. The possibility that this organism enters into a state of nonculturability in cold seawater and the pathogenicity of the nonculturable cells was examined. The nonculturable state of V. vulnificus and, for comparison, that of Escherichia coli were studied in artificial-seawater microcosms at 5 C. Total cell counts were monitored by acridine orange epifluorescence, metabolic activity by direct viable counts, and culturability by plate counts on selective and nonselective media. Whereas total counts remained constant, plate counts of V. vulnificus suggested nonculturability by day 24. In contrast, direct viable counts indicated significant cell viability throughout 32 days of incubation. As an indication of the metabolic changes that occurred as cells entered the state of nonrecoverability, membrane fatty acid analyses were performed. At the point of nonculturability of V. vulnificus, the major fatty acid species (C16 and C16:1) had decreased 57% from the T0 level, concomitant with the appearance of several short-chain acids. Although the bacteria were still-recoverable, a similar trend was observed with E. coli. Electron microscopy of nonculturable V. vulnificus showed that the cells were rounded and reduced in size and contained fewer ribosomes. Mouse infectivity studies conducted with these cells suggested loss of virulence. (Geiger-PTT)
W90-04031

IONSPRAY MASS SPECTROMETRY/MASS SPECTROMETRY: QUANTITATION OF TRIBUTYLTIN IN A SEDIMENT REFERENCE MATERIAL FOR TRACE METALS.
National Research Council of Canada, Ottawa (Ontario). Div. of Chemistry.
K. W. M. Siu, G. J. Gardner, and S. S. Berman.
Analytical Chemistry ANCHAM, Vol. 61, No. 20, p 2320-2322, October 1989. 4 fig, 1 tab, 16 ref.

Descriptors: *Water analysis, *Sediments, *Mass spectrometry, *Organotin compounds, *Pollutant identification, Trace metals, Quantitative analysis, Tin.

Tributyltin (TBT) concentration in a sediment reference material for trace metals, PACS-1, was determined by using ionspray mass spectrometry/mass spectrometry. TBT was extracted into isooctane or 1-butanol, diluted with methanol containing 1 mM ammonium acetate, delivered to the ionspray tandem mass spectrometer by using flow injection, and quantitated by means of selected reaction monitoring of the daughter/parent pair of m/z 179/291. The minimum detectable amount of TBT was about 5 picograms of Sn absolute or 0.2 micrograms of Sn/gm of sediment. PACS-1 was found to contain tributyltin at a concentration of 1.29 +or-0.07 microgram of Sn/gm of sediment. (Author's abstract)
W90-04037

HOLLOW FIBER MEMBRANE PROBES FOR THE IN SITU MASS SPECTROMETRIC MONITORING OF NITROGEN TRICHLORIDE FORMATION DURING WASTEWATER TREATMENT.
Dow Chemical Co., Midland, MI. Analytical Sciences.
For primary bibliographic entry see Field 5D.
W90-04038

MANUAL HEADSPACE METHOD TO ANALYZE FOR THE VOLATILE AROMATICS OF GASOLINE IN GROUNDWATER AND SOIL SAMPLES.
Connecticut Univ., Storrs. Dept. of Chemistry.
V. D. Roe, M. J. Lacy, J. D. Stuart, and G. A. Robbins.
Analytical Chemistry ANCHAM, Vol. 61, No. 22, p 2584-2585, November 1989. 1 tab, 12 ref.

Descriptors: *Gasoline, *Aromatic compounds, *Pollutant identification, Groundwater pollution, Soil contamination, Water analysis, Benzenes, Gas chromatography.

A manual headspace method is described for analyzing volatile aromatics of gasoline (benzene, toluene, ethylbenzene, and three xylene isomers, BTEX) in contaminated soil and groundwater. Separations were performed with a capillary column gas chromatograph. A split/splitless injector was used in the splitless mode. Megabore capillary column, 0.55 mm in diameter, 30 m in length with 3.0-micrometer film thickness were used. The column's eluent was passed through a photoionization detector equipped with a 10.2 eV lamp, followed by a flame ionization detector. The photoionization detector was connected to one integrator while the flame ionization detector output was monitored by the gas chromatography terminal. The method proved to be a rapid and effective means of analyzing environmental samples. Brief run times of 15-20 min and lack of sample work-up allow up to 20 samples to be analyzed in an 8-hr work day. The photoionization detector has a useful analytical range for BTEX in water extending from about 1 microgram/liter to at least 15000 micrograms/liter using this method. (Geiger-PTT)
W90-04039

CONTAMINANTS IN BLUBBER, LIVER AND KIDNEY TISSUE OF PACIFIC WALRUSES.
Fish and Wildlife Service, Anchorage, AK.
For primary bibliographic entry see Field 5B.
W90-04064

DETERMINATION OF FLUORIDE IN NATURAL WATERS BY ION-SELECTIVE ELECTRODE POTENTIOMETRY AFTER CO-PRECIPITATION WITH ALUMINIUM PHOSPHATE.
Nihon Univ., Tokyo. Dept. of Industrial Chemistry.
For primary bibliographic entry see Field 7B.
W90-04066

DETERMINATION OF MERCURY IN ENVIRONMENTAL SAMPLES BY COLD VAPOUR GENERATION AND ATOMIC-ABSORPTION SPECTROMETRY WITH A GOLD-COATED GRAPHITE FURNACE.
Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea).
S. H. Lee, K. H. Jung, and D. S. Lee.
Talanta TLNTA2, Vol. 36, No. 10, p 999-1003, October 1989. 4 fig, 4 tab, 12 ref.

Descriptors: *Mercury, *Atomic absorption spectrophotometry, *Pollutant identification, *Water analysis, Gold, Graphite, Quantitative analysis, Natural waters, Marine animals, Sediments.

A technique was developed to determine mercury with sufficient sensitivity for a small volume of water to be analysis directly. Mercury is determined at below the picogram/ml level by a combination of cold vapor generation, trapping in a gold-coated graphite furnace and atomic-absorption detection. The mercury is reduced to the element by stannous chloride, stripped from solution by a stream of nitrogen and collected on a gold-coated porous graphite disk in a graphite furnace. It is then atomized by increasing the graphite furnace temperature and detected by an atomic-absorption spectrophotometer. The absolute detection limit and the characteristic mass were 5 and 20 picograms for 0.0044 absorbance, respectively. The concentration limit of detection was 0.1 picogram/milliliter for a 50-ml sample, and the linear dynamic range covered three orders of magnitude. The precision of the measurements was 2.7% for 0.1 nanogram and 2.6% for 2 nanograms of mercury. Analyses of NBS and NIES reference materials showed quantitative recovery. Analytical results obtained by the technique are tabulated as follows: (1) lake water in Soyang, Korea, 3.3 nanograms/L at 50 m to 8.7 nanograms/L at the surface; (2) rain water also at Soyang, 3.9 nanograms/L; (3) mussels from several Korean coastal areas, 0.021 to 0.102 microgram/gm dry wt; and (4) sediments from Ulsan Bay, Korea, 0.08 micrograms/gm dry wt at 23-26 cm (representing the 1932-1938 deposition period) to 0.18 microgram/gm dry wt at 0-2 cm (representing the 1981-1985 deposition period). (Geiger-PTT)
W90-04067

AQUATIC TOXICITY OF COMPLEX EFFLUENTS.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
R. Lloyd.
Chemistry and Industry CHINAG, No. 14, p 449-452, July 17, 1989. 3 fig, 9 ref.

Descriptors: *Water analysis, *Pollutant identification, *Toxicity, *Testing procedures, Bioassay, Chemical analysis.

The Ministry of Agriculture, Fisheries and Food Fisheries Laboratory has considerable experience with complex wastes that are licensed for dumping at sea. Considerable information on the potency of complex wastes can be obtained from simple toxicity tests, in particular those from which concentration:response curves can be derived. However, it is important to separate the two functions of a bioassay clearly in this context. They may be used to measure the potency of an effluent as a surrogate for chemical analysis, and the test organism may be used as a surrogate for other aquatic species in order to predict the effect of the discharge on the biota in the receiving water. In that case, there are considerable uncertainties, but this should not affect the acceptance of bioassays for measuring the potency of an effluent as a surrogate for chemical analysis. The next challenge is the development of a suitable bioassay, with a readily available test organism, that does not require specialist staff or facilities. (Mertz-PTT)
W90-04093

CONCENTRATION OF GIARDIA LAMBLIA CYSTS, LEGIONELLA PNEUMOPHILA, CLOSTRIDIUM PERFRINGENS, HUMAN ENTERIC VIRUSES, AND COLIPHAGES FROM LARGE VOLUMES OF DRINKING WATER, USING A SINGLE FILTRATION.
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
For primary bibliographic entry see Field 5F.
W90-04095

WQSTAT II: A WATER QUALITY STATISTICS PACKAGE.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 7C.
W90-04165

TESTING FOR TREND IN LAKE AND GROUND WATER QUALITY TIME SERIES.
Colorado State Univ., Fort Collins. Dept. of Statistics.
C. H. Taylor, and J. C. Loftis.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 715-726, August 1989. 3 fig, 16 ref. EPA Cooperative Agreement No. CR-813997-01-0.

Descriptors: *Acid rain effects, *Lake water quality, *Statistical analysis, *Water quality, *Groundwater pollution, *Data processing, Lakes, Seasonality, Comparison studies, Water quality control.

The detection of gradual trends in water quality time series is increasing in importance as concern grows for diffuse sources of pollution such as acid precipitation and agricultural non-point sources. A significant body of literature has arisen dealing with trend detection in water quality variables that exhibit seasonal patterns. Much of the literature has dealt with seasonality of the first moment. However, little has been mentioned about seasonality in the variance, and its effect upon the performance of trend detection techniques. Eight methods of trend detection that arise from both the statistical literature as well as the water quality literature were compared by means of a simulation study. The methods compared were: (1) Seasonal Kendall Without Correction for Correlation (SKWOC); (2) Seasonal Kendall With Correction for Correlation; (3) Farrells Test; (4) Analysis of Covariance (ANCOV); (5) Mann-Kendall on Deseasonalized Data (MKDD); (6) Modified T-Test (MTT); (7) Analysis of Covariance on Ranks (ANCOVR); and (8) Modified T-Test on Ranks (MTTR). Varying degrees of seasonality in both the variances and the means were introduced into the artificial data, and the performances of these procedures were analyzed. Since the focus was on lake and groundwater quality monitoring, quarterly sampling and short to moderate record lengths were examined. Comparisons were made using independent random errors with lognormal and normal distributions and using normally distributed errors with positive correlations. In general, the SKWOC appears to be a good method for detecting trends as long as the random errors were uncorrelated. None of the tests were adequate for detecting trends in data with correlated random errors, but the SKWC was better than the other seven tests. (Author's abstract)
W90-04167

EVALUATION OF SOME APPROACHES TO ESTIMATING NON-POINT POLLUTANT LOADS FOR UNMONITORED AREAS.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
R. P. Richards.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 891-904, August 1989. 4 fig, 4 tab, 21 ref.

Descriptors: *Statistical methods, *Pollution load, *Nonpoint pollution sources, *Data acquisition, *Monitoring, *Water pollution sources, Watersheds, Comparison studies, Extrapolation techniques.

Evaluation of the non-point source pollutant load entering a lake from multiple tributaries requires either that all tributaries be monitored or that some extrapolation method be used to estimate loads originating in areas not monitored. Unmonitored areas include not only watersheds of tributaries that are not monitored, but also portions of a monitored tributary's drainage basin downstream from the monitoring site and areas of direct drainage. Significant portions of large lake drainage basins are often not monitored, and loads for these areas are often estimated by extrapolation. Six simple extrapolation procedures were evaluated by using them to estimate loads for areas that had been monitored and comparing the estimated loads with the monitored loads. Three approaches were based on inter-basin ratios of area, C-factor, and discharge. The other approaches used regression relationships between concentration and flow to estimate concentrations for the unmonitored basin. The ratio approaches generally were more reliable than the regression approaches. However, extrapolation by any method tested was not very precise. Some methods also were biased when applied to watersheds of a size different than the monitored one. Extrapolation by any of these methods would compromise the precision of the lake-wide load estimate, if the unmonitored area were a significant part of the entire basin. (Author's abstract)
W90-04187

ESTIMATING MEAN AND VARIANCE FOR ENVIRONMENTAL SAMPLES WITH BELOW DETECTION LIMIT OBSERVATIONS.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 7C.
W90-04188

EVALUATION OF CONTROL CHART METHODOLOGIES FOR RCRA WASTE SITES.

Nevada Univ., Las Vegas. Environmental Research Center.
For primary bibliographic entry see Field 5G.
W90-04247

1987 SAVANNAH RIVER CURSORY SURVEYS.
Academy of Natural Sciences of Philadelphia, PA. Div. of Environmental Research.
For primary bibliographic entry see Field 2H.
W90-04268

5B. Sources Of Pollution

PROCESSES OF BALLAST WATER DISPERSAL.
ENTRIX, Inc., Anchorage, AK.
For primary bibliographic entry see Field 5E.
W90-03613

SEDIMENTATION PROCESSES.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 2J.
W90-03614

HYDROCARBON ACCUMULATIONS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
D. G. Shaw.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 243-265, 4 fig, 2 tab, 26 ref.

Descriptors: *Arctic zone, *Hydrocarbons, *Oil pollution, *Valdez, *Fate of pollutants, *Alaska, Bioaccumulation, Ballast water, Polycyclic aromatic hydrocarbons, Mollusks, Wastewater disposal.

Several investigations of hydrocarbons in the sediments, animals and water of Port Valdez have been reported. Before completion of the marine terminal of the trans Alaska pipeline, biogenic hydrocarbons dominated most of the samples analyzed. Operation of the terminal has included the permitted discharge of treated ballast water containing on the order of 10 mg/L residual petroleum enriched in single ring aromatic hydrocarbons. During summer when the water column of the port is stratified, a plume of ballast water hydrocarbons has been detected at approximately 50 m water depth in the vicinity of the treated ballast water discharge point. Sediments near the discharge point have accumulated a suite of hydrocarbons associated with the discharge but dominated by higher molecular weight molecules than those most abundant in the plume. After 5 years of terminal operation sediment concentrations of petroleum marker compounds (hopanes and polycyclic aromatic hydrocarbons) decreased away from the discharge point; by 10-fold at 800 m and 100-fold at 3 km. It appears that only a very small fraction of the discharged petroleum (< 3%) is incorporated into these sediments. Intertidal bivalve mollusks in the port also show signs of the accumulation of anthropogenic hydrocarbons. In this case the contaminant source appears to be complex. Small oil spills and combustion residues as well as treated ballast water probably contribute, but in unknown proportions. (See also W90-03610) (Lantz-PTT)
W90-03620

HYDROCARBON BIOCONVERSIONS: SOURCES, DYNAMICS, PRODUCTS AND POPULATIONS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
D. K. Button, and B. R. Robertson.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 267-291, 7 fig, 3 tab, 40 ref.

Descriptors: *Aromatic compounds, *Arctic zone, *Hydrocarbons, *Alaska, *Biodegradation, *Fate of pollutants, *Valdez, Bacteria, Microbial degradation, Biomass, Kinetics, Organic compounds, Ballast water.

Dissolved hydrocarbons, particularly the more soluble mononuclear aromatics, and bacteria are liberated into Port Valdez, Alaska, the bacteria without significant influence by the ballast water treatment facility. Turnover times due to bioconversions of the hydrocarbons themselves range from a few days to many decades depending on distance from the point of effluent due to declining populations of hydrocarbon oxidizing bacteria with distance. Laboratory studies indicate that the chief products of microbial activity are carbonyl derivatives of the parent hydrocarbons followed by carbon dioxide and microbial biomass in a ratio that depends on the state of induction. Kinetic studies indicate that the turnover time of these products is greater than that of the parent hydrocarbons due to smaller specific affinities. These products are probably formed in the ballast chambers of the tankers, in the ballast treatment facility and in the receiving waters of Port Valdez. (See also W90-03610) (Lantz-PTT)
W90-03621

EVIDENCE FOR HISTORICAL HEAVY METAL POLLUTION IN FLOODPLAIN SOILS: THE MEUSE.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
M. C. Rang, and C. J. Schouten.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 127-142. 2 fig, 13 tab, 10 ref.

Descriptors: *Sediment contamination, *Water pollution sources, *Path of pollutants, *Meuse River, *History, *Heavy metals, *Pollution load, *Flood plain management, Water pollution effects, Alluvial deposits, Flood frequency, Zinc, Cadmium, Lead, Copper, Soil types, Lime, Organic matter, Soil contamination, Silt, Mine wastes, Catchment areas, Erosion, Deposition, Flood plains, Belgium, Sediment erosion.

Pedological and geochemical surveys of flood plain sediments may be applied to evaluate the spatial effect of pollution within hydrosystems, and to determine the historical changes of pollution loading. These techniques were applied to the heavy metal pollution of the River Meuse (Germany) sediments, with particular attention paid to the relationship between soil development and frequency of flooding on the one hand and the degree of pollution on the other hand. This not only gives a good spatial picture of the extent of the pollution but also reveals the historical developments involved. All the flood plain soils of the Meuse that have a frequency of flooding of at least once per 250 years are polluted to some degree. The concentrations of zinc, cadmium, lead, and copper are particularly high. There seems to be a strong relationship between the degree of pollution of the uppermost layer of the soil and the soil type. The youngest soils, which are rich in lime and organic matter, appear to be the most polluted. The peak of pollution was reached about 100 years ago, coinciding with the zenith of ore mining in the Belgian part of the catchment. After erosion during high water the polluted river sediments that have been deposited on the flood plain form a secondary source of pollution that can have a strong and longlasting effect on the quality of the river silt. (See also (W90-03689) (Fish-PTT)
W90-03697

HANDBOOK OF ENVIRONMENTAL FATE AND EXPOSURE DATA FOR ORGANIC CHEMICALS.
Syracuse Research Corp., NY. Center for Chemical Hazard Assessment.
P. H. Howard.
Volume I: Large Production and Priority Pollutants, 1989. Lewis Publishers, Inc., Chelsea, Michigan. 574 p.

Descriptors: *Handbooks, *Fate of pollutants, *Water pollution sources, *Path of pollutants, *Pollutant identification, *Data collections, *Priority pollutants, Monitoring, Chemical analysis, Molecular structure, Chemical properties, Physical properties, Biodegradation, Path of pollutants, Volatilization, Aquatic environment.

The environmental fate and exposure of approximately 75 large production organic chemicals and priority pollutants are reported by describing in detail how individual chemicals are released, transported, and degraded in the environment and how they are exposed to humans and environmental organisms. Available data on physical/chemical properties, commercial use and possible sources of environmental contamination, environmental fate, and monitoring data of individual chemicals are reviewed and evaluated. Each review of a chemical provides: substance identification; boil point, melting point, molecular weight, dissociation constants, log octanol/water coefficient, water solubility, vapor pressure, Henry's Law constant, and environmental fate/exposure potential (such as natural sources, artificial sources, terrestrial fate, aquatic fate, atmospheric fate, biodegradation, abiotic degradation, bioconcentration, soil adsorption/mobility, volatilization from water/soil). (Lantz-PTT)
W90-03748

SUPERFUND RECORD OF DECISION: CALIFORNIA GULCH, CO.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-03750

SUPERFUND RECORD OF DECISION: BRIO REFINING, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-03751

SUPERFUND RECORD OF DECISION: NINTH AVENUE DUMP, IN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-03752

METHODOLOGY, RESULTS, AND SIGNIFICANCE OF AN UNSATURATED-ZONE TRACER TEST AT AN ARTIFICIAL-RECHARGE FACILITY, TUCSON, ARIZONA.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03754

QUALITY OF SURFACE AND GROUND WATER AT AND ADJACENT TO THE LOS ALAMOS NATIONAL LABORATORY: REFERENCE ORGANIC COMPOUNDS.
Los Alamos National Lab., NM.
W. D. Purtymun, R. W. Ferenbaugh, and M. Maes.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-015055. Price codes: A03 in paper copy, A01 in microfiche. Report No. LA-11333-MS, August 1988. 25p, 1 fig, 4 tab, 11 ref, 4 append.

Descriptors: *Path of pollutants, *Water pollution sources, *Fate of pollutants, *Groundwater pollution, *Surface water, *Organic compounds, Los Alamos, New Mexico, Volatile organic compounds, Phenols, Dibutylphthalate, Dichlorobenzene, Pesticides, Herbicides, Cyanide, Polychlorinated biphenyls.

Surface and groundwater samples were collected from 43 stations representing the major occurrences of natural and municipal water and industrial and sanitary effluents in the Los Alamos area. The samples were analyzed for volatile organics (35 compounds), semivolatile organics (65 compounds), base neutral acid fraction, pesticides (20 compounds), herbicides (3 compound), polychlorinated biphenyls (7 compounds), and cyanides. The investigation was performed to find possible areas of organic contamination for further study; however, the impact of organic contamination in surface and groundwater is minimal. Volatile organic com-

pounds were reported from seven stations in concentrations ranging from 5 to 23 micrograms/L (ug/L). The compounds were below the maximum contaminant level (MCL) where it has been determined by the EPA. Semivolatile organic compounds were determined in waters from 11 different stations in concentrations ranging from 14 to 560 ug/L. Five different semivolatile compounds were reported from the water supply distribution system at two fire stations. They were phenol (7 ug/L), di-n-butyl phthalate (170 ug/L), and three types of dichlorobenzene (20 to 23 ug/L). Pesticide, herbicide, and polychlorinated biphenyls (PCB) analyses of water from the 43 stations were below detection limits and were below the existing or proposed MCL. Traces of cyanide above the detection limit (10 ug/L) were reported in waters from two effluent release areas. The concentrations were low, ranging from 20 to 40 ug/L. The source of the cyanides in the two effluent areas is unknown as other stations in the same effluent release areas did not contain cyanide. The concentrations were well below the MCL of 200 ug/L. (Lantz-PTT)
W90-03763

RELATIONSHIP OF ESTUARINE PLANT CONTAMINANTS TO EXISTING DATA BASES.
European Research Office, London (England).
For primary bibliographic entry see Field 5C.
W90-03765

MAGNITUDE OF THE GROUND-WATER CONTAMINATION PROBLEM.
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
J. W. Keeley.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 2-10, 1 fig, 1 tab, 9 ref.

Descriptors: *Groundwater pollution, *Water pollution sources, *Path of pollutants, Septic tanks, Cesspools, Landfills, Land disposal, Coal mining effects, Chlorides, Nitrates, Heavy metals, Hydrocarbons, Irrigation-return flow.

The groundwater pollution problems outlined in this paper were essentially gleaned from six reports on the subject. One is a Report to Congress provided in January 1977. The remaining five reports discuss groundwater availability, use, and backgrorund quality for various geographical areas of the United States. Some problems indigenous to one area may not exist in others but several sources of groundwater contamination are dominant at a high or moderate degree of severity in each area investigated. Among these, septic tanks and cesspools, petroleum exploration and development, landfills, irrigation return flows, and surface waste impoundments appear to be the most troublesome problems. The application of municipal and industrial sludges to the land has not been of major concern in the past but is expected to be so in the future due primarily to the federal legislation seeking to eliminate stream discharges by 1985. Similarly, coal mining activities are increasing in the United States, due to the energy shortage, and are expected to present greater groundwater pollution problems in the future. The four pollutants most commonly reported in these five regional investigations are chlorides, nitrates, heavy metals, and hydrocarbons. This brings into focus the need to more actively include organic and biological parameters in future studies. (See also W90-03771) (Lantz-PTT)
W90-03772

SURFACE AND SUBSURFACE MINING: POLICY IMPLICATIONS.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Div. of Mine Drainage Control and Reclamation.
For primary bibliographic entry see Field 5G.
W90-03775

OIL WELL OPERATION/MAINTENANCE AND SALTWATER INTRUSION: POLICY IMPLICATIONS.
Cities Service Oil Co., Charleston, WV.
V. Meier.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 35-39.

Descriptors: *Environmental protection, *Water pollution prevention, *Oil wells, *Saline water intrusion, *Oil industry, *Public policy, Waste disposal, Oil wastes, Regulations, Drinking water, Maintenance, Oil spills, Dikes, Drilling fluids, Absorption, Emulsifiers, Blowouts, Water pollution protection, Groundwater.

In the operation of oil wells, drilling is a temporary but very important operation. When wells are drilled with air or foam using fresh water as the drilling medium, the medium is not circulated back into the well bore during drilling but retained in earthen pits. Wells are also drilled with fluid consisting of fresh or salt water. Additives are added to these waters to obtain certain properties so that it becomes a drilling mud. The fluid is circulated back into the well bore during drilling by using mud pits and an earthen reserve pit. Drilling operations must have a Spill Prevention Control and Countermeasures Plan (SPCC Plan) which is required by the EPA. These plans specify that dikes or containment devices by built around fuel tanks. Waste oil from equipment must be collected by ditches and dikes. Pits must be constructed to contain spills from the well. Materials such as straw, sawdust, sand, form pads, and emulsifiers must be available to clean up spills. Blow-out preventers must be on the well while drilling through possible oil and gas horizons to control hydrocarbons if they come to the surface. Additional regulations could substantially decrease ultimate recovery of hydrocarbons. If more regulations are needed to insure that underground sources of drinking water will not be endangered, then well-documented evidence from major oil and gas producing states must be obtained to show that, in fact, additional requirements are essential. (See also W90-03771) (Lantz-PTT)
W90-03777

WISCONSIN REGIONAL INTEGRATED LAKE-WATERSHED ACIDIFICATION STUDY (RILWAS): 1981-1983.
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
Interim Report, January 1989. 282 p. EPRI Research Project 2174-2. Edited by D. Knauer, and S. A. Brouwer.

Descriptors: *Watersheds, *Path of pollutants, *Lake acidification, *Wisconsin, *Acid rain, *Water pollution sources, Snowmelt, Hydrogen ion concentration, Water chemistry, Sulfates, Chemistry of precipitation, Dry deposition, Hydrologic budget, Round Lake, East Eightmile Lake, Groundwater movement.

Round and East Eightmile lakes, small (14-15 ha) seepage lakes in thick (332-190 m) sandy outwash in northwestern Wisconsin, were studied from September 1981 through August 1983. Precipitation was 5-15% < normal during the first year and 7-15% > normal during the second year. Snowfall accounted for 24-34% of the precipitation; however, all snowmelt infiltrated the highly permeable soils, and no spring depression in lake pH was observed. Chemistry of the precipitation was dominated by hydrogen ion, ammonium, and sulfate. Volume-weighted mean pH of bulk precipitation was 4.6 at both sites during the study with hydrogen ion and ammonium contributing 60% of the cations. Volume-weighted mean lake pH's during the study were 6.4 at Round Lake and 6.9 at East Eightmile Lake. Hydrologic budgets indicate that inflow to the lakes was precipitation dominated (67-88%), whereas outflow was primarily evaporation (68-92%). The remaining flows were groundwater inflow and outflow. Direct atmospheric deposition accounted for the majority of hydrogen ion, chloride, and inorganic nitrogen inputs to the lakes, whereas, groundwater inflow supplied most of the calcium, magnesium, sodium, alkalinity, and silica. Sulfate and potassium were contributed primarily by direct deposition at Round Lake and by groundwater at East Eightmile Lake. The groundwater basins upgradient from the lakes retained hydrogen ion and inorganic nitrogen relative to chloride. Potassium, sulfate, sodium, calcium, magnesium, alkalinity, and silica were released from the basins. Modification and application of the Integrated Lake-Watershed Acidification Study (ILWAS) simulation model suggest the following needs for better calibration: (1) a 4-5 yr database, particularly for the hydrologic module; (2) more research on aerosol collection efficiency and leaf-area index of the canopy; and (3) inclusion of in-lake oxidation-reduction processes. A preliminary 8-year simulation with a 50% reduction in atmospheric sulfur deposition at Round Lake showed that the lake sulfate concentrations decreased 37%, alkalinity concentrations increased 16%, and pH decreased by < 0.1 unit. (See W90-03791 thru W90-03797) (Lantz-PTT)
W90-03790

ATMOSPHERIC INPUT.
Wisconsin Univ.-Madison.
J. G. Bockheim, J. Flickinger, J. E. Leide, and J. A. Morton.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 21-63, 23 fig, 5 tab, 14 ref, 3 append.

Descriptors: *Water pollution sources, *Wisconsin, *Acid rain, *Air pollution, Round Lake, East Eightmile Lake, Ions, Ammonium, Calcium, Magnesium, Potassium, Hydrogen ion concentration, Acidic water, Path of pollutants, Dry deposition, Nitrates, Sulfates.

A study was conducted to: (1) measure precipitation quantity and quality in two watersheds with contrasting lakes in northwestern Wisconsin; and (2) assist in predicting the effects of acidic deposition on the lakes. Specific objectives were to measure wet/dry deposition at Round Lake and bulk precipitation at Round and East Eightmile lakes and to compare ion fluxes in bulk precipitation and wet and dry deposition at Round Lake. Ion fluxes were measured in bulk precipitation collected at Round and East Eightmile lakes during 1981-82 and 1982-83 and in wet/dry deposition collected at Round Lake during 1982-83. The ranking of cations in bulk precipitation at both watersheds over the 2-yr period was H-ion and NH4, Ca, Mg, K; Na, anions were ranked SO4, NO3, Cl. The volume-weighted mean annual pH of bulk precipitation ranged between 4.54 and 4.70 at the two watersheds over the 2-yr period. The annual variations in ion fluxes in bulk precipitation at a given watershed were < 20% (coefficient of variance), except for K at Round Lake. Although no statistical comparisons were made, annual fluxes of ions were similar at the two watersheds for a given budget year. Ion fluxes in bulk precipitation varied seasonally in accordance with variations in volume of precipitation. Fluxes commonly were lower in the winter months when the quantity of precipitation was lower than during the remainder of the year. There were no significant differences in ion fluxes between bulk precipitation and wet + dry deposition at Round Lake in 1982-83, except for lesser amounts of NH4 and Na in bulk precipitation. Given that bulk precipitation had greater amounts of NO3 and significantly lesser amounts of NH4 than wet + dry deposition, microbial transformations may have occurred in the bulk collectors between sampling events. Dry deposition contributed approximately 20% of the total cations and anions in wet + dry deposition at Round Lake in 1982-83. (See also W90-03790) (Lantz-PTT)
W90-03792

TERRESTRIAL COMPONENT.
Wisconsin Univ., Madison.
J. G. Bockheim, J. E. Leide, L. C. Sheng, E. A. Jepsen, and J. M. Esser.

IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 64-89, 12 tab, 132 ref.

Descriptors: *Path of pollutants, *Acid rain, *Geohydrology, *Buffering, *Wisconsin, *Throughfall, Forests, East Eightmile Lake, Round Lake, Vegetation, Hydrogen ion concentration, Calcium, Ammonium, Magnesium, Potassium, Soil chemistry.

The specific objectives of the terrestrial component of the Wisconsin watershed project were: (1) to compare statistically the fluxes of ions in water moving through the predominant terrestrial ecosystems of the two watersheds; and (2) to evaluate the sensitivity of the terrestrial ecosystems to acidic deposition. Hydrogen ions contributed by acidic deposition are neutralized by terrestrial ecosystems at Round and East Eightmile lakes. The vegetation plays an initial role in this buffering process. Whereas the fluxes of H ion and NH4 were significantly less in throughfall, fluxes of Ca, Mg, and K commonly were greater in throughfall of all forest types examined than in bulk precipitation. Throughfall fluxes of base cations generally were greater beneath deciduous forest types (aspen, mixed oak, paper birch) than beneath coniferous vegetation (jack pine). However, differences in fluxes of ions at the bottom of the rooting zone as a function of vegetation, including areas devoid of woody vegetation, were minimal. This is due to greater uptake rates of base ions by the deciduous vegetation, especially for Ca, than for the other vegetation types. Therefore, buffering of H ion appears to be accomplished predominantly in the soil profile. Mineralogic studies revealed that plagioclase feldspar, hornblende, olivine, and augite are undergoing chemical alteration. In contrast, the more resistant orthoclase feldspar and quartz are accumulating in the upper soil horizons. The Omega soil, the dominant soil of each watershed, contains from 45-55% weatherable minerals in the 100-50 micrometer fraction. Buffering reactions in the soil may include hydrolysis of silicate minerals, ion exchange, and mineralizations of soil organic matter. (See also W90-03790) (Lantz-PTT)
W90-03793

HYDROLOGIC COMPONENT.
Geological Survey, Madison, WI. Water Resources Div.
D. A. Wentz, W. J. Rose, and J. T. Krohelski.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 90-167, 26 fig, 16 tab, 45 ref.

Descriptors: *Acid rain, *Wisconsin, *Groundwater, *Precipitation, *Hydrologic budget, *Surface-groundwater relations, East Eightmile Lake, Water table fluctuations, Seasonal variation, Snowmelt, Chemical analysis, Hydrogen ion concentration, Silicates, Sulfates, Round Lake.

Total annual precipitation and its monthly distribution are similar at Round and East Eightmile lakes in northwestern Wisconsin. Snowpack accumulation and snowmelt are analogous at the two sites, with most differences resulting from differences in cover type. Annual lake evaporation is equal to or slightly less than precipitation at the two sites. Lake stage and water table fluctuations follow each other at the two sites. Water table altitudes reached minimum values during May 1982 and increased from then until the end of the study period, in August 1983, in response to greater than normal precipitation. Round Lake fully penetrates and interacts with the saturated thickness of the drift, but East Eightmile Lake is partially penetrating. Both lakes are groundwater flow-through types. The hydrologic budgets indicate that inflow to both lakes is dominated by precipitation (67-70% for East Eightmile Lake and 85-88% for Round Lake). Water residence times are 8 to 10 years at Round Lake, but chemical residence times are on the order of 100 years. Changes in watershed snowpack chemistry during spring snowmelt show that 57-66% of the ion load is released with the first 29-44% of the melt water. However, surface runoff to the lakes is nonexistent. Silicate hydrolysis is the dominant weathering process controlling groundwater chemistry at both study areas. Hydroxyl ion released by this process accounts for the buffering capacity of the groundwater. Longer contact time in the deeper groundwater allows equilibrium to be approached, resulting in higher pH's and saturation with respect to calcite. Sulfate reduction appears to be occurring at both sites as water passes from upgradient groundwater through the lake water to downgradient groundwater. Decreasing pH's in upgradient groundwater during the two years of the study may have resulted from increased recharge, which also has caused water table altitudes and lake stages to increase. (See also W90-03790) (Lantz-PTT)
W90-03794

CHEMICAL INPUT-OUTPUT BUDGETS.
Geological Survey, Madison, WI. Water Resources Div.
D. A. Wentz, P. J. Garrison, and J. G. Bockheim.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 196-221, 2 fig, 11 tab, 16 ref.

Descriptors: *Chlorides, *Water pollution sources, *Chemical analysis, *Path of pollutants, *Acid rain, *Wisconsin, East Eightmile Lake, Round Lake, Surface-groundwater relations, Calcium, Magnesium, Potassium, Sodium, Air pollution, Sulfates, Groundwater movement, Groundwater pollution.

Assuming that chloride is conservative within a lake system, analysis of chloride budgets at Round and East Eightmile lakes in northwestern Wisconsin indicates that neither errors in volume (hydrologic budget) nor errors in chloride concentration for any single budget component were likely to account for the overall chloride budget errors. Chloride budgets supported the hydrologic budgets for both lakes. Direct atmospheric deposition provided most of the hydrogen ion, chloride, and inorganic nitrogen inputs to both lakes, whereas groundwater inflow accounted for the majority of the calcium, magnesium, sodium, alkalinity, and silica inputs. Inputs of potassium and sulfate were primarily from groundwater at East Eightmile Lake but at Round Lake, where groundwater inflow was smaller, these constituents came primarily from atmospheric deposition. Both lakes retained hydrogen ion, silica, inorganic nitrogen, and sulfate, but released alkalinity to the groundwater system. Calcium and magnesium were released from East Eightmile Lake, but behaved approximately as chloride in Round Lake. Calcium, magnesium, potassium, and sodium mass increased as atmospheric deposition passed through the forest canopy and soil to the base of the rooting zone, whereas mass of hydrogen ion, and inorganic nitrogen decreased. Changes in sulfate mass were variable. The mass of most constituents decreased during passage from the deep soil to the groundwater. The latter decrease was due primarily to a reduction in solution volume. Concentrations of potassium, sodium, hydrogen ion, and inorganic nitrogen in the groundwater were equal to or less than those in the deep soil leachate; however, concentrations of calcium, magnesium, and sulfate in groundwater were greater than in deep soil leachate. (See also W90-03790) (Lantz-PTT)
W90-03796

MODELLING COMPONENT.
Tetra Tech, Inc., Lafayette, CA.
S. A. Gherini, and C. W. Chen.
IN: The Wisconsin Regional Integrated Lake-Watershed Acidification Study (RILWAS): 1981-1983. Interim Report, January 1989. p 222-281, 21 fig, 5 tab, 6 ref, append.

Descriptors: *Limnology, *Lake acidification, *Acid rain effects, *Hydrologic models, *Model studies, *Wisconsin, Round Lake, East Eightmile Lake, Water chemistry, Sulfates, Surface-groundwater relations, Snowpack, Wisconsin Regional Integrated Lake-Watershed Acidification.

The Wisconsin Regional Integrated Lake-Watershed Acidification (RILWAS) project was initiated to determine the influence of acid deposition on Wisconsin's surface waters and at the same time to test the applicability of the ILWAS simulation model to such systems. During this RILWAS study, the model was applied to several lakes in the Adirondacks, a mountain stream system in the Coweeta Experimental Forest in North Carolina, and to two seepage lakes in Wisconsin: Round and East Eightmile lakes. In applying the model to the Wisconsin seepage lakes, certain difficulties were encountered. Unlike the other RILWAS water bodies, all lake outflow in Round and East Eightmile lakes, other than evaporation, is by groundwater seepage. This type of outflow cannot be directly measured and, therefore, cannot be used for model calibration. In addition, all inflow, other than direct precipitation, is groundwater seepage, from variable source areas. Specifically, the size of the watersheds tributary to the lake are not constant but change with time. The suite of acid-base chemical processes simulated by the model is quite large, including wet and dry deposition, tree growth, biomass decay, ion exchange, weathering, algal growth, etc. Unlike the previously modeled water bodies, however, the hydraulic residence time in the two Wisconsin lakes is long and in-lake alkalinity-producing reactions such as sulfate reduction, which were not included in the ILWAS model, become quantitatively important. These factors have made application of the ILWAS model to the two northern Wisconsin watershed systems the most demanding application to date. Application of the model required modifications for seepage inflow and outflow and of the calibration procedures. Input data included soil properties, snowpack and soil parameters, and lake characteristics. The modified model simulated snowpack depths, lake evaporation, groundwater elevations, lake stage, and ice thickness with a reasonable degree of accuracy. There were some discrepancies (e.g. under-prediction of snowpack) which may be attributable to errors in the model, the data, or both. (See also W90-03790) (Lantz-PTT)
W90-03797

PETROLEUM CONTAMINATED SOILS. VOLUME I: REMEDIATION TECHNIQUES, ENVIRONMENTAL FATE, RISK ASSESSMENT.
For primary bibliographic entry see Field 5G.
W90-03830

SOILS CONTAMINATED BY MOTOR FUELS: RESEARCH ACTIVITIES AND PERSPECTIVES OF THE AMERICAN PETROLEUM INSTITUTE.
American Petroleum Inst., Washington, DC.
B. J. Bauman.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 3-19, 1 tab, 34 ref.

Descriptors: *Soil contamination, *Oil pollution, *Fate of pollutants, *Cleanup operations, Environmental protection, American Petroleum Institute, Research priorities, Hydrocarbons, Fuel.

The general nature of the processes that affect motor fuel in soils are discussed, emphasizing the natural propensity for contaminant depletion in soils which in turn mitigates potential environmental risks. The importance of careful definition and evaluation of the potential risks that are uniquely associated with each site has also been emphasized. It has been demonstrated that at any given site, any potential risks are the result of the: nature and level of the contamination; site-specific conditions which influence possible routes of contaminant exposure; and the proximity of potential receptors (e.g., human populations) to the contaminated soil. It is important to appreciate that the inherent diversity among sites dictates that a regulatory program possess sufficient flexibility to allow for the design of site-specific cleanup goals and technical strategies to achieve them. This can best be achieved through an evaluation of the potential environmental, public health, and safety risks present at a site, as opposed to strict assignment of numerical standards as cleanup objectives. Work-

ing together within this framework, industry and the regulatory community can provide practical solutions to the complex problem of soil contamination by petroleum hydrocarbons. The American Petroleum Institute will continue its research efforts to provide an improved understanding of soil contamination and its mitigation. The regulatory community can facilitate the development of innovative cleanup techniques by encouraging careful experimentation with new methods, and by streamlining the permitting process required for such projects. Perhaps more importantly, by continuing efforts in the area of prevention of petroleum hydrocarbon releases to the environment, it will be possible to maximize the protection of soil and groundwater quality. (See also W90-03830) (Lantz-PTT)
W90-03831

STATE'S PERSPECTIVE OF THE PROBLEMS ASSOCIATED WITH PETROLEUM CONTAMINATED SOILS.
Orange County Div. of Environmental Health, CA. Hazardous Waste Management Section.
For primary bibliographic entry see Field 5G.
W90-03832

PROBLEMS DEALING WITH PETROLEUM CONTAMINATED SOILS: A NEW JERSEY PERSPECTIVE.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
For primary bibliographic entry see Field 5G.
W90-03833

FEDERAL UNDERGROUND STORAGE TANK REGULATIONS AND CONTAMINATED SOILS.
Environmental Protection Agency, Washington, DC. Office of Underground Storage Tanks.
R. A. Valentinetti.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 55-60, 2 ref.

Descriptors: *Underground waste disposal, *Underground storage, *Waste disposal, *Soil contamination, Oil pollution, Path of pollutants, Cleanup operations, Technology, Hazardous wastes.

Although federal regulations are necessary to initiate cleanup of soils contaminated with petroleum, EPA Office of Underground Storage Tanks (OUST) is enthusiastic about pursuing any activities that will enhance the cleanup of contaminated soil 'outside the regulations.' One function of the federal government is to provide basic assistance and tools to its franchisees. The greatest need for this approach is in the area of contaminated soils, because so little information currently is available. With the assistance of the Office of Research and Development (ORD), the following two-pronged attack on this problem has been initiated: focus on better understanding the physical and chemical mechanisms that retain and release petroleum that has been absorbed into the soil; and evaluate innovative technologies for transforming existing treatment levels and achieve low level. The objectives of this first project will be: (a) to characterize the mechanism of hydrocarbon migration, retention, and transformation in the saturated, as well as unsaturated zones; and (b) to use this information to improve removal technologies, especially in in situ settings. These objectives could also be described as fate and transport as it applied to corrective action. The second ORD effort will be to evaluate some innovative technologies in the field, somewhat similar to the Superfund Innovative Technology Evaluation Program (SITE program). Through the SITE program, EPA will assist in commercially developing and demonstrating the use of promising new technologies at hazardous waste sites. The UST program will try to build on the technology development and experience of SITE's program. (See also W90-03830) (Lantz-PTT)
W90-03834

MODELING PETROLEUM PRODUCTS IN SOILS.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
L. Eastcott, W. Y. Shiu, and D. Mackay.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 63-80, 7 fig, 2 tab, 17 ref.

Descriptors: *Soil contamination, *Oil pollution, *Path of pollutants, *Model studies, *Fate of pollutants, Biodegradation, Quantitative analysis, Hydrocarbons, Chemical analysis.

It is relatively easy to describe the fate of petroleum in soils in merely qualitative terms. For example, it is clear that volatile petroleum products such as gasoline experience considerable loss by evaporation; normal alkanes are subject to fairly rapid biodegradation; aromatic hydrocarbons, particularly those of lower molecular weight, are very susceptible to dissolution into water and may thus cause contamination of water supplies in the locality. It is, however, much more difficult to make rigorous, scientifically justifiable statements in which these processes are described in quantitative terms. It is believed, however, that by a combination of complementary laboratory studies and field studies, it should be possible to develop an improved capability of predicting the fate of petroleum in soils. One approach toward developing this capability is the study of the fate of oil in laboratory soil microcosms or 'soil boxes'. This approach has the advantage that more information can be obtained with greater accuracy and precision, and modeling is easier. There are two distinct intellectual challenges in this work. The first is to design and conduct experiments, and interpret the resulting data to obtain an understanding of the dominant processes and their approximate rates. The second task is to formulate a mathematical model which will consist of equations founded in physical and chemical reality, and which describe only the more significant processes. The various parameters in this model must then be determined, as well as their dependence on variables such as temperature, soil type, oxygen status, and availability of nutrients. A suite of models is now emerging that describe the fate of oil in soils. Some will treat the migration or flow of the bulk phase under the action of gravity and hydraulic and capillary forces. Others will treat the gradual decay of hydrocarbons over a period of months as they are subject to evaporation, dissolution, and biodegradation. The purpose of these models is not just to describe the science of chemical fate in soil, but to contribute to an improved ability to describe, respond to, and mitigate the fate and effects of hydrocarbons in real spill situations. (See also W90-03830) (Lantz-PTT)
W90-03835

MOVEMENT AND RETENTION OF ORGANICS IN SOIL: A REVIEW AND A CRITIQUE OF MODELING.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
D. Hillel.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 81-86.

Descriptors: *Path of pollutants, *Fate of pollutants, *Soil contamination, *Model studies, Soil texture, Water table, Soil properties, Soil water.

The migration, retention, and transformation of mobile materials in the soil is affected by the nature of the soil. Among the properties and conditions of the soil which affect the flow regime are the following: (1) soil type, or, to simplify, soil texture; (2) the vertical uniformity or nonuniformity of the soil; (3) the configuration of the soil layers; (4) the depth to the water table; (5) the structure of the soil; (6) the possibility of unstable flow; and (7) soil moisture. Modeling allows, in principle, the development of some statistical and simulation methods to handle several processes and effects simultaneously. Computer-based models appear capable of reducing a complex system to one of orderly and manageable proportions. The very exercise of designing, operating, and testing such models has helped gain more insight into the workings of an actual system, and to develop criteria to predict its behavior under varying conditions. The process of modeling consists of choosing the facts and factors deemed to be most relevant and essential to the solution of a perceived problem, and then formulating the relationships governing these factors. Therefore, it is a basically subjective exercise. (See also W90-03830) (Lantz-PTT)
W90-03836

APPLICABILITY OF POSSM TO PETROLEUM PRODUCT SPILLS.
CH2M/Hill, Bellevue, WA.
W. J. Shields, and S. M. Brown.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 87-104, 6 fig, 3 tab, 8 ref. EPRI Contract RP 2634-1.

Descriptors: *Oil pollution, *Path of pollutants, *Soil contamination, *Fate of pollutants, *Model studies, *Oil spills, POSSM, Simulation analysis.

Petroleum products are complex mixtures of hydrocarbons with widely varying physical-chemical properties. When spilled on soil, the environmental behavior of a petroleum product is controlled by a number of processes. The need to evaluate potential environmental and human health impacts has prompted risk analysts to use chemical transport and fate models to predict the potential environmental behavior of petroleum products in soil. Most of the available models simulate the transport and fate of chemicals in the soluble phase, rather than the immiscible phase. Most of the available models were also developed for individual chemicals, not mixtures of chemicals. Thus, risk analysts are currently faced with the problem of trying to apply single-component, solute transport models to petroleum product spills. One model that potentially fills the gap that currently exists between the available modeling technology and needs of the risk analyst is the Polychlorinated Biphenyl Onsite Spill Model (POSSM). The POSSM model may fill a gap for risk analysts who need to evaluate potential impacts associated with petroleum product spills. An initial evaluation of potential simulation strategies suggests that either the binary mixture or Monte Carlo versions of POSSM are the most applicable. Of the simulation strategies that were identified, the individual component-mixture and soluble-insoluble fraction strategies appear to be the most applicable. Field or laboratory data are needed to test the applicability of each version of POSSM and each simulation strategy, and to further assess potential limitations. (See also W90-03830) (Lantz-PTT)
W90-03837

UTILITY OF ENVIRONMENTAL FATE MODELS TO REGULATORY PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
M. A. Callahan.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 105-112, 1 fig, 3 tab, 13 ref.

Descriptors: *Fate of pollutants, *Management planning, *Model studies, Risk assessment, Regulations, Population exposure.

The role of an environmental fate model in a regulatory agency such as EPA is as a predictive tool useful in estimating both present and potential exposures. The EPA Guidelines for Estimating Exposure define exposure as the contact with a chemical or physical agent. The magnitude of this contact is determined by measuring or estimating the amount of an agent available at the exchange boundaries (i.e., lungs, gut, skin) during some specific time. Three approaches are commonly used to evaluate exposure: (1) direct measurement of exposure; (2) reconstructive exposure assessment approach; and (3) predictive exposure assessment ap-

proach. Risk management decisions in EPA depend not only on risk assessment, but also on other factors such as cost and practicability. Environmental fate models can be powerful tools in helping assess both current situations and predicting the results of control alternatives being considered, but fate models themselves do not direct decisions. Models are an important part of a much larger process of risk assessment and risk management, and it is this process that the agency decision makers use to help them make regulatory decisions. (See also W90-03830) (Lantz-PTT)
W90-03838

EVALUATION OF ORGANIC MATERIALS THAT INTERFERE WITH STABILIZATION/SOLIDIFICATION PROCESSES.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W90-03840

SUPERFUND EXPOSURE ASSESSMENT MANUAL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135859. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/540/1-88/001, April 1988. 157p, 15 fig, 27 tab, 177 ref, 3 append.

Descriptors: *Path of pollutants, *Handbooks, *Fate of pollutants, *Pollutant identification, *Path of pollutants, *Water pollution sources, *Superfund, Monitoring, Hazardous wastes, Water pollution effects.

The analytical process outlined in the Superfund Exposure Assessment Manual provides a framework for the assessment of exposure to contaminants at or migrating from uncontrolled hazardous waste sites. The application of both monitoring and modeling procedures in the exposure assessment process is outlined. This process considers all contaminant releases and exposure routes and assures that an adequate level of analytical detail is applied to support the human health risk assessment process. The analytical process is structured in five segments: (1) analysis of contaminant releases from a subject site into environmental media; (2) evaluation of the transport and environmental fate of the contaminants released; (3) identification, enumeration, and characterization of potentially exposed populations; (4) integrated exposure analysis; and (5) uncertainty analysis. The Superfund Exposure Assessment Manual supports the development of exposure assessments that are consistent from site to site, and provides a means of documenting that each site receives adequate evaluation. The procedures presented reflect current (at the time of publication) state-of-the-art methods for conducting an exposure assessment. However, it is important for the analyst to recognize that exposure assessment is a developing science. Although the overall protocol for conducting exposure assessments at Superfund sites will not change significantly over time and the basic parameters needed as input to the analysis are not likely to change, alternative analytical methods may be developed for many parts of the assessment. The methods presented in the manual can serve as a benchmark against which such new methods can be compared. (Author's abstract)
W90-03849

DEVELOPMENT OF IDEAS ON THE NATURE AND AGENTS OF BIOMETHANOGENESIS.
California Univ., Davis. Dept. of Bacteriology.
For primary bibliographic entry see Field 5D.
W90-03851

ACETATE METABOLISM BY METHANOSARCINA.
Wisconsin Univ., Madison. Dept. of Bacteriology.
For primary bibliographic entry see Field 5D.
W90-03852

METABOLISM OF H2 AND CO2 BY METHANOBACTERIUM.
Marburg Univ. (Germany, F.R.). Fachbereich Biologie.
For primary bibliographic entry see Field 5D.
W90-03854

EFFECT OF HYDROGEN CONCENTRATION ON POPULATION DISTRIBUTION AND KINETICS IN METHANOGENESIS OF PROPIONATE.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03855

ENERGETICS OF H2-PRODUCING SYNTROPHIC BACTERIA.
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 5D.
W90-03856

LINK BETWEEN HYDROGEN AND SULFUR METABOLISMS IN METHANOSARCINA BARKERI (DSM 800).
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France).
For primary bibliographic entry see Field 5D.
W90-03858

ASSIMILATORY REDUCTION OF N2 AND NO3 BY METHANOCOCCUS THERMOLITHOTROPHICUS.
Iowa Univ., Iowa City. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W90-03859

PRELIMINARY ANALYSIS FOR TRENDS IN SELECTED WATER QUALITY CHARACTERISTICS, POWDER RIVER, MONTANA AND WYOMING, WATER YEARS, 1952-85.
Geological Survey, Helena, MT. Water Resources Div.
L. E. Cary.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4050, June 1989. 25p, 4 fig, 6 tab, 12 ref.

Descriptors: *Salinity, *Statistical analysis, *Stochastic process, *Water quality, *Montana, *Wyoming, Surface water.

Selected water-quality data from two streamflow-gaging stations on the Powder River, Montana and Wyoming, were statistically analyzed for trends using the seasonal Kendall test. Data for water years 1952-63 and 1975-85 from the Powder River near Locate, Montana, and water years 1967-68 and 1976-85 from the Powder River at Sussex, Wyoming, were analyzed. Data for the earlier period near Locate were discharge-weighted monthly mean values, whereas data for the late period near Locate and at Sussex were from periodic samples. For data from water years 1952-63 near Locate, increasing trends were detected in sodium and sodium-adsorption ratio; no trends were detected in specific conductance, hardness, non-carbonate hardness, alkalinity, dissolved solids, or sulfate. For data from water years 1975-85 near Locate, increasing trends were detected in specific conductance, sodium, sodium-adsorption ratio, and chloride; no trends were detected in hardness, noncarbonate hardness, alkalinity, dissolved solids, calcium, magnesium, potassium, or sulfate. At Sussex (water years 1967-68 and 1976-85), increasing trends were detected in sodium, sodium-adsorption ratio, and chloride, and a decreasing trend was detected in sulfate. No trends were detected in specific conductance, alkalinity, or dissolved solids. When the 1967-68 data were deleted and the analysis repeated for the 1976-85 data, only sodium-adsorption ratio displayed a significant (increasing) trend. Because the study was exploratory, causes and effects were not considered. The results might have been affected by sample size, number of seasons, heterogeneity, significance level, serial correlation, and data adjustment for changes in discharge. (USGS)
W90-03877

CONSTRUCTION DATA AND RETRIEVAL PROCEDURES FOR SELECTED WELLS DRILLED FROM 1985 THROUGH 1987 AT OAK RIDGE NATIONAL LABORATORY, TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03878

HYDROGEOLOGY, BRACKISH-WATER OCCURRENCE, AND SIMULATION OF FLOW AND BRACKISH-WATER MOVEMENT IN THE AQUIA AQUIFER IN THE KENT ISLAND AREA, MARYLAND.
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2F.
W90-03879

EFFECTS OF THREE HIGHWAY-RUNOFF DETENTION METHODS ON WATER QUALITY OF THE SURFICIAL AQUIFER SYSTEM IN CENTRAL FLORIDA.
Geological Survey, Orlando, FL. Water Resources Div.
D. M. Schiffer.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4170, 1989. 79p, 38 fig, 20 tab.

Descriptors: *Highway effects, *Groundwater quality, *Florida, *Water quality, *Water pollution sources, Surficial aquifer system, Aeration zone, Swales, Detention ponds, Retention ponds, Exfiltration systems.

Water quality of the surficial aquifer system in central Florida was evaluated at one exfiltration pipe, two ponds (detention and retention), and two swales in central Florida, representing three runoff-detention methods, to detect any effect from infiltrating highway runoff. Concentrations of major ions, metals, and nutrients in groundwater and bottom sediments were measured from 1984 through 1986. At each study area, constituent concentrations in groundwater near the structure were compared to concentrations in groundwater from an upgradient control site. Groundwater quality data were also pooled by detention method and statistically compared to detect any significant differences between methods. Significantly greater mean phosphorus concentrations in groundwater near the exfiltration pipe than those in the control well was the only evidence of increasing constituent concentrations in groundwater near structures. The quality of water was more variable, and had greater constituent concentrations in the unsaturated zone than in the saturated zone near the exfiltration pipe. Values of water quality variables measured in groundwater at all study areas generally were within State drinking water standards. The main exception was dissolved iron, which commonly exceeded 300 micrograms/L at one swale and the detention pond. Results of the study indicate that natural processes occurring in soils attenuate inorganic constituent concentrations prior to reaching the receiving groundwater. However, organic compounds detected in bottom sediments at the retention pond indicate a potential problem that may eventually affect the quality of the receiving groundwater. (USGS)
W90-03884

HYDROLOGY OF THE PROSPECTOR SQUARE AREA, SUMMIT COUNTY, UTAH.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03885

PHYSICALLY BASED NETWORK MODEL FOR TWO- AND THREE-PHASE SATURATION–CAPILLARY PRESSURE RELATIONSHIPS.

Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 2G.
W90-03890

EFFECT OF NUTRIENTS AND PESTICIDES APPLIED TO TURF ON THE QUALITY OF RUNOFF AND PERCOLATING WATER.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
For primary bibliographic entry see Field 5G.
W90-03894

REGRESSION MODELS FOR ESTIMATING URBAN STORM-RUNOFF QUALITY AND QUANTITY IN THE UNITED STATES.
Geological Survey, Denver, CO.
N. E. Driver, and B. M. Troutman.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 221-236, August 1989. 2 fig, 2 tab, 22 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Model studies, *Urban watersheds, *Urban runoff, *Urban hydrology, *Storm runoff, *Rainfall-runoff relationships, Management planning, Regression analysis, Statistical methods, Drainage area, Nitrogen, Ammonia.

Urban planners and managers need information about the local quantity of precipitation and the quality and quantity of storm runoff if they are to plan adequately for the effects of storm runoff from urban areas. As a result of this need, linear regression models were developed for the estimation of storm-runoff loads and volumes from physical, land-use, and climatic characteristics of urban watersheds throughout the United States. Three statistically different regions were delineated, based on mean annual rainfall, to improve linear regression models. One use of these models is to estimate storm-runoff loads and volumes at gaged and ungaged urban watersheds. The most significant explanatory variables in all linear regression models were total storm rainfall and total contributing drainage area. Impervious area, land-use, and mean annual climatic characteristics were also significant explanatory variables in some linear regression models. Models for dissolved solids, total nitrogen, and total ammonia plus organic nitrogen were the most accurate models for most areas, whereas models for suspended solids were the least accurate. The most accurate models were those for the more arid western United States, and the least accurate models were those for areas that had large quantities of mean annual rainfall. (Author's abstract)
W90-03904

GROUNDWATER'S DYANAMIC ROLE IN REGULATING ACIDITY AND CHEMISTRY IN A PRECIPITATION-DOMINATED LAKE.
Wright State Univ., Dayton, OH. Dept. of Geological Science.
For primary bibliographic entry see Field 2H.
W90-03907

MODELING SOLUTE TRANSFER FROM SOIL TO SURFACE RUNOFF: THE CONCEPT OF EFFECTIVE DEPTH OF TRANSFER.
Agricultural Research Service, Riverside, CA. Salinity Lab.
R. Wallach, M. T. Van Genuchten, and W. F. Spencer.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 307-317, August 1989. 4 fig, 1 tab, 15 ref.

Descriptors: *Model studies, *Soil water, *Path of pollutants, *Water pollution sources, *Nonpoint pollution sources, *Solute transport, *Soil properties, *Hydrologic models, *Surface runoff, Runoff, Mass transfer, Soil horizons, Aeration zone, Sorption, Mathematical equations.

A model for predicting the transfer of chemicals from soil to surface runoff water is described. The model applies a perfectly mixed reactor analog to an equivalent and homogeneous soil layer of uniform concentration near the soil surface, called the 'Effective Depth of Transfer' (EDT). Solute concentrations in the EDT model are taken to be equal to the soil surface concentrations as determined by an analytical solution of the one-dimensional diffusion equation for the limiting case of no infiltration. The model considers linear equilibrium sorption-exchange, and also accounts for rate-limited mass transfer through a laminar boundary layer at the soil surface-runoff water interface. The time-dependent EDT was found to vary as a linear function of the square root of tie. The accuracy of the EDT approach is illustrated with one example, which compares the EDT solution for the soil surface concentration with the exact analytical solution of the diffusive mass transfer equation. The ability to change values of the physically based parameters adds considerable flexibility in application of the model to different locations with site-specific runoff regimes, soil properties, and solute characteristics. (Author's abstract)
W90-03908

HYDROCHEMICAL BUDGETS FOR THE LOCH DEE EXPERIMENTAL CATCHMENTS, SOUTHWEST SCOTLAND (1981-1985).
Saint Andrews Univ. (Scotland). Dept. of Geography and Geology.
For primary bibliographic entry see Field 2K.
W90-03911

STUDY OF THE DEPOSITIONAL ENVIRONMENTS OF THE DELTA OF THE EBRO BY MENAS OF MOLECULAR INDICATORS (ESTUDIO DE LOS AMBIENTES DEPOSICIONALES DEL DELTA DEL EBRO MEDIANTE INDICADORES MOLECULARES).
Centro de Investigacion y Desarrollo, Barcelona (Spain). Environmental Chemistry Dept.
For primary bibliographic entry see Field 5A.
W90-03928

ABSORPTION OF SULFUR DIOXIDE ON MONODISPERSE WATER DROPLETS AND CATALYTIC ACTIVITY OF CARBON PARTICLES.
Istituto FISBAT-CNR, Bologna, Italy.
G. Santachiara, F. Prodi, and F. Vivarelli.
Atmospheric Environment ATENBP, Vol. 23, No. 8, p 1775-1782, August 1989. 4 fig, 2 tab, 38 ref.

Descriptors: *Path of pollutants, *Clouds, *Atmospheric water, *Acid rain, *Chemistry of precipitation, Chemical properties, Catalysts, Sulfur, Sulfates, Acidic water, Atmosphere.

Two laboratory experiments on heterophase transformations leading to cloudwater acidification were conducted. The first measured the SO2 absorption from monodisperse water droplets without catalyzers. With gas-phase concentration of SO2=100 +or-4 ppm at t=25 C, the mean sulfur concentration in the droplets after contact time t=0.02 s is conc. S(IV)=1.4 +or-0.2 times 0.001 M, i.e. conc. S(IV)=0.95 conc. S(IV) sub e. These experimental results are compared with values calculated from theoretical models. In the second experiment, the catalytic activity of carbon particles is examined for SO2 oxidation, again on monodisperse water droplets. With conc. SO2 sub g = 25 +or-2 ppmv at t=25 C, the mean value for sulfate produced in solution catalyzed by C is: Conc. SO4(2-)=0.56 +or-0.001 M after a contact time of 54 s. These experiments on SO2 absorption by monodisperse water droplets without catalyzers demonstrate that droplets of 3 microns radius reach in t=0.01s a total S concentration in solution of S(IV) =0.95 (conc. S(IV))sub e, where (conc. S(IV)) sub e is the equilibrium value with the environment. Given the experimental errors, this result compared well with most theoretical models. (Author's abstract)
W90-03933

VERTICAL PROFILES OF AIR POLLUTANTS IN A SPRUCE FOREST: ANALYSIS OF ADHERENT WATER, THROUGHFALL AND DEPOSITS ON SURROGATE SURFACES.
Fraunhofer-Inst. fuer Umweltchemie und Oekotoxikologie, Schmallenberg (Germany, F.R.).
U. Fritsche, M. Gernert, and C. Schindler.
Atmospheric Environment ATENBP, Vol. 23, No. 8, p 1807-1814, August 1989. 3 fig, 4 tab, 14 ref. German Umweltbundesamt, Berlin, Contract 10607/01.

Descriptors: *Path of pollutants, *Air pollution, *Germany, *Throughfall, *Acid rain, *Chemistry of precipitation, Canopy, Forests, Acidic water, Atmospheric water, Acid rain effects.

Vertical profiles of air pollutants were studied in a spruce forest, which exhibits damage mainly in the upper parts of the canopy. The sampling included plant surface water, throughfall and surrogate surfaces at five different heights. The vertical profiles of dry deposition for air pollution are determined largely by the wind speed. After a dry period a small amount of rain yields vertical profiles of the components of plant surface water which are similar to the profile of the wind speed. As the amount of rain increases sufficiently to cause wash-off, the location of the maximum of the concentrations shifts downward. The adherent water shows remarkable increases in acidity from top to bottom. The vertical deposition and the face up deposition are in the same order of magnitude, but the first is more influenced by the wind speed and the second more by the precipitation. The face down deposition is relatively low. These findings agree with previous theories. High concentrations at the needle surface are to be expected after a dry period, when the accumulated deposit is dissolved in a small amount of water. In that case for several components the vertical profiles correspond to the extent of the damage. Exceptions are H(+) and NH4(+) because of leaching and uptake, respectively. The observation of more damage on the upper side of the branches compared with undersurface also corresponds to the variation of the deposition. (Friedmann-PTT)
W90-03934

OBSERVED AND MODELED TREND OF SULFATE AND NITRATE IN PRECIPITATION IN EASTERN NORTH AMERICA.
Massachusetts Inst. of Tech., Cambridge. Energy Lab.
J. A. Fay, D. Golomb, and S. G. Zemba.
Atmospheric Environment ATENBP, Vol. 23, No. 8, p 1863-1866, August 1989. 2 fig, 1 tab, 11 ref.

Descriptors: *Chemistry of precipitation, *Path of pollutants, *Sulfates, *Nitrates, *Acid rain, Model studies, Comparison studies, Regression analysis, Statistical methods, Air pollution, Precipitation.

The trend of annual average sulfate and nitrate ion concentrations in precipitation at 17 stations in eastern North America over 7 years, 1979-1985, is estimated and compared with a modeled trend. The observed concentrations fluctuate from year-to-year about a mean value with a standard deviation of 12.7% on average. The average slope of a linear regression line at the 17 stations is minus 2.8%/a for sulfate and minus 0.4%/a for nitrate. The modeled trend at these stations, which assumes constant meteorology but a year-to-year varying emission inventory, is minus 2.4%/a for sulfate and minus 0.9%/a for nitrate. Since the observed trend at an individual station is greatly influenced by the year-to-year meteorological variations and random measurement errors (resulting in a low confidence level of the estimated trend), the agreement between the modeled isocontours and the observed trend at any station ranges from fair to poor. However,since the 17-station average observed trend is in reasonable agreement with the 17-station average modeled trend, it was concluded that the modeled isocontour maps give a fair representation of the annual average SO4(2+) and NO3(-) concentration trend in precipitation over the period 1979-1985. (Friedmann-PTT)
W90-03935

MICROBIAL DEGRADATION OF BENZENE AND TOLUENE IN GROUNDWATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
U. Karlson, and W. T. Frankenberger.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 505-510,

October 1989. 3 fig, 8 ref.

Descriptors: *Biodegradation, *Microbial degradation, *Groundwater pollution, *Fate of pollutants, *Path of pollutants, *Toluenes, *Benzenes, Organic compounds, Hydrocarbons, Limiting factors, Nitrogen.

Biodegradation of benzene and toluene in groundwater, upon amendment with nutrients and an enriched hydrocarbon oxidizing culture, was assessed. Gasoline-contaminated groundwater was collected from a monitoring well. The groundwater sample had the following chemical and biological properties: pH, 7.93; TOC, 23 micrograms/mL; NH4-N, 0.22 micrograms/mL; NO3-N, 0.21 micrograms/mL; total P, 0.37 micrograms/mL; petroleum hydrocarbon content, 6.2 mg/L; benzene, 477 micrograms/L; toluene, 561 micrograms/L; xylenes, 153 micrograms/L; gasoline degrading bacterial population, 710 colony-forming units(CFU)/mL; total heterotrophs, 3430 CFU/mL. The treatments consisted of: (1) sterile control; (2) unamended groundwater; (3) amended with 100 mg/L NH4NO3-N; and (4) amended with NH4NO3-N (100 mg/L) plus a 1-mL inoculum of an enrichment culture consisting of gasoclastic microflora. In all non-sterilized treatments, the toluene concentration dropped dramatically within 30 h. The amount of time required for toluene to decrease to acceptable limits by microbial degradation was 23, 17 and 14 h for the unamended sample, groundwater plus a N source, and groundwater inoculated with the enriched culture of hydrocarbon oxidizers plus a N source, respectively. The benzene content slowly degraded in the unamended sample, but dramatically dropped in concentration in the N-treated water and in the inoculated plus N-amended water. The bacterial population capable of utilizing gasoline as a C and energy source was relatively low, but comparable to that reported for groundwater samples involving a gasoline pipeline leakage. This study revealed that both components (oxygen and nitrogen) were major limiting factors in the biodegradation of benzene and toluene. (Friedmann-PTT)
W90-03937

BACTERIAL ABUNDANCE AND ACTIVITY IN HAZARDOUS WASTE-CONTAMINATED SOIL.
Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Biological Sciences.
D. Dean-Ross.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 511-517, October 1989. 3 tab, 9 ref.

Descriptors: *Fate of pollutants, *Phenol, *Soil contamination, *Soil bacteria, *Toxicity, *Microbial degradation, *Biodegradation, Hazardous materials, Inhibition, Cleanup operations.

The activity of indigenous microbial populations at a hazardous waste site was determined, as well as their degree of adaption to toxic chemicals present in the waste mixture and their ability to degrade toxic organic compounds, using phenol as a model substrate. It was found that hazardous waste contaminated soils possess active populations of soil microorganisms, which, in this particular case, are more abundant and more active than adjacent, noncontaminated soil. Abundance and activity of bacterial populations varied considerably from site to site and may be related to differences in nutrient status or the presence of inhibitory chemicals. Phenol degrading capacity of the soils varied from location to location and could not be directly correlated with either total numbers of bacteria present, numbers of phenol degrading bacteria present, or phenol concentration at the site. It is proposed that phenol itself , as well as other contaminants at the site, may be exerting inhibitory effects on bacteria with phenol degrading capabilities. The observed heterogeneity will have to be taken into consideration in implementing bioremediation of contaminated soils. (Friedmann-PTT)
W90-03938

COVARIATION OF SELECTED TRACE ELEMENTS WITH BINDING SUBSTRATES IN CORES COLLECTED FROM TWO CONTAMINATED SEDIMENTS.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
T. E. Lewis, and A. W. McIntosh.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 518-528, October 1989. 1 fig, 2 tab, 25 ref.

Descriptors: *Heavy metals, *Trace elements, *Sediments, *Path of pollutants, Substrates, Pollution load, Lead, Zinc, Chromium, Copper, Nickel, Iron, Vertical distribution, Manganese, Storm runoff, Statistical analysis.

Sediments serve as a final sink for many trace elements in the aquatic environment. The vertical distribution of various trace elements, and their covariance with certain binding substrates within two contaminated sediments, was examined. Sediment cores were analyzed for seven elements using flame atomic absorption spectrometry: Pb, Zn, Cr, Cu, Ni, Fe, and Mn. There was a general lack of strong correlations between most metals in Delaware and Raritan Canal (DRC), as compared with Weston's Mill Pond (WMP). This finding may be due, in part, to the wide diversity of metal sources in the canal. WMP receives its metal loadings primarily from stormwater runoff, while DRC receives metal loadings from over 67 major industries, institutions, and commercial establishments. Thus, metal ratios in WMP would tend to be more constant over time as compared to DRC. The vertical distribution of trace elements may be strongly dependent upon the vertical distribution of certain binding substrates (e.g., Fe and Mn oxides, organics, sulfides, carbonates). Significant correlations between Pb, Zn, Cu, and Cr, and the oxide substrate elements Fe and Mn were noted in WMP sediments, and to a lesser degree in DRC sediments over depth. It is likely that trace elements deposited in association with oxides of Fe and Mn may redistribute to alternate binding substrates (e.g., organics, carbonates, sulfides) in deep, reduced sediments, provided sufficient available binding sites are available on these alternate substrates. Also, pH and redox conditions must be conducive for binding sites on other substrates to be active. (Friedmann-PTT)
W90-03939

LEAD AND CHROMIUM CONCENTRATIONS IN THE POTABLE WATER OF THE EASTERN PROVINCE OF SAUDI ARABIA.
King Faisal Univ., Damman (Saudi Arabia). Coll. of Medicine and Medical Sciences.
H. M. A. Hassan, H. T. Mustafa, and T. I. Rihan.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 529-533, October 1989. 4 tab, 7 ref.

Descriptors: *Pollutant identification, *Potable water, *Heavy metals, *Lead, *Chromium, *Water analysis, *Drinking water, Water quality standards, Water quality, Saudi Arabia, Public health, Trace elements.

Lead and chromium concentration were studied in the potable water of the Eastern Province of Saudi Arabia to provide a more complete profile of the levels of heavy metals in this Province. All samples were analyzed with flame atomic absorption spectrophotometry. Two hundred eighty-eight water samples, or 93.5% of the 308 analyzed for lead were below the World Health Organization (WHO) and U.S. Public Health Service (USPHS) limits for this element, and 20 samples, or 6.5%, exceeded the upper limit of acceptability. For chromium, 259 samples, or 84.1%, were below the WHO and USPHS limit of 0.05 mg/L, and 49 samples, or 15.9%, located mainly in Hasa and Dammam, were above the limit. A survey of the water sampling locations, especially those with lead concentrations above the limit, indicated that these samples, particularly in Dammam and Jubail, were taken either from coolers or wells where lead or lead-lined service pipes were used. While it is easy to explain the presence of industrial discharge leading to elevated chromium levels in water in Dammam, a metropolis with major industrial activities, an acceptable culprit cannot be found to explain the presence of chromium at elevated concentrations in Hasa, a city with few industries and extensive cultivation. (Friedmann-PTT)
W90-03940

DISTRIBUTION AND RESIDUE LEVEL OF MERCURY, CADMIUM AND LEAD IN KOREAN BIRDS.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
D. P. Lee, K. Honda, R. Tatsukawa, and P. Won.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 550-555, October 1989. 2 tab, 17 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Mercury, *Cadmium, *Lead, *Waterfowl, *Heavy metals, *Korea, Physiological ecology, Aquatic habitats.

The tissue distributions of three toxic metals, Hg, Cd and Pb, in 16 bird species in Korea were investigated. The residue levels were also studied in relation to the feeding habits and habitats. After dissection, liver, kidney, pectoral muscle, bone, and breast feathers were taken for metal analysis. The bone samples were taken from the femur, and the adhering muscle and red marrow were removed. The samples and feathers were analyzed using a flame atomic absorption spectrophotometer. The presence of Hg was determined by cold-vapor atomic absorption spectrophotometry. Detection limits for each of the metals were: Hg. 0.005 ppm; Cd, 0.01 ppm, and Pb, 0.05 ppm. Tissue distributions of the metals were metal-specific: the highest value of Hg was in feathers, and those fo Cd and Pb were in kidney and bone, respectively. Relatively high values of Hg and Cd were found in liver. Pb exhibited relatively high values in feathers, but was not detected in muscle, liver and kidney for most of the samples. These distribution patterns agreed well with earlier results. The value of Hg was highest in carnivorous birds such as sparrow hawk, buzzard and kestrel, and lowest in herbivorous ones such as mallard and swan. Cd and Pb were accumulated in relation to the feeding habits of birds. The highest value of Cd was found in omniovorous species such as black-tailed gull; the value of Pb was highest in insectivorous species such as thrushes and relatively high in herbivorous waterfowl. As a whole, the levels of found of the three metals studied indicated that these pollutants are negligible in Korean birds. However, relatively high Cd levels in black-tailed gulls from Masan Bay suggest Cd pollution in this area. (Friedmann-PTT)
W90-03941

ASSESSMENT OF EXPOSURE TO ENVIRONMENTAL MICROCONTAMINANTS AND PESTICIDE RESIDUES IN SCAPHARCA INAEQUIVALVIS.
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
A. di Domenico, C. La Rocca, C. Lintas, and L. T. Baldassarri.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 556-563, October 1989. 4 fig, 11 ref.

Descriptors: *Pesticides, *Polycyclic aromatic hydrocarbons, *Bioaccumulation, *Pollutant identification, *Water pollution effects, *Organic pesticides, *Mollusks, DDT, DDD, Organic compounds, Gas chromatography, Scapharea, Pollutant identification.

Samples of the mollusk Scapharca inaequivalvis, taken from the Italian coastal Adriatic Sea, were used to detect microcontaminants, including polycyclic aromatics, and pesticide residues in marine ecosystems and to assess their impact on the ecosystems involved. Recovery yields were tested only for HCB, lindane, DDD, and DDT. They were added at two different levels (10 and 100 ppb) to freshwater test fish during homogenization. However, because of the absence of interfering gas chromatography signals, 0.5-ppb-level HCB was added to Scapharca sample matrices during homogenization to provide an additional measure of recovery yield. For all pesticides, recovery yields

were always > 50% and in most cases between 70% and 100%. Gas chromatography-mass spectrometry assessment of pesticides PCB, PCDD, and PCDF in wholebody and bloodless matrices provided similar findings. HCB, heptachlor, and lindane were absent at a detection threshold of < 0.1 ppb; DDD and DDT exhibited levels (uncorrected) between 40 and 120 ppb. PCB varied according to the isomer group from 4 to 30 ppb, the more chlorinated terms exhibiting somewhat higher levels. No PCDD and PCDF were found at a detection threshold of < 0.2 ppb for the least sensitive terms (octochloro-derivatives). The presence of blood did not seem to significantly change the analytical patterns of the matrices analyzed. (Friedmann-PTT)
W90-03942

CALIBRATION OF THE FRESHWATER MUSSEL, ELLIPTIO COMPLANATA, FOR QUANTITATIVE BIOMONITORING OF HEXACHLOROBENZENE AND OCTACHLOROSTYRENE IN AQUATIC SYSTEMS.
Windsor Univ. (Ontario). Great Lakes Inst.
For primary bibliographic entry see Field 5A.
W90-03943

COMPARATIVE HYDROCHEMICAL BUDGETS AND WEATHERING AND ACIDIFICATION RATES IN THREE SMALL SIMILAR GRANITIC WATERSHEDS WITH CONTRASTED VEGETATION (MONT LOZERE, FRANCE) (COMPARAISON DES BILANS HYDROCHIMIQUES, DES TAUX D'ALTERATION ET D'ACIDIFICATION DANS TROIS PETITS BASSINS VERSANTS GRANITIQUES SIMILAIRES A VEGETATION CONTRASTEE (MONT LOZERE, FRANCE)).
Orleans Univ. (France). Lab. d'Hydrogeologie.
F. Lelong, P. Durand, and J. Didon.
Sciences Geologiques (Bulletin) BIGPA8, Vol. 41, No. 3-4, p 263-278, 1988. 8 fig, 7 tab, 19 ref. English summary.

Descriptors: *Watersheds, *Solute transport, *Geologic erosion, *Acid rain, *Geochemistry, *Weathering, Minerals, Hydrologic cycle, Rainfall-runoff relationships, Catchment areas.

Since 1981, hydrological and hydrochemical measurements have been continuously performed in three small neighboring watersheds. Located on the southern slope of Mount Lozere, France (1200-1500 m above sea level), the basins have similar geological (grantici basement) and physiographic characteristics, except the vegetation cover. The first purpose of the study (1981-1984) was to compare the values of mineral losses caused by chemical weathering in the three ecosystems and, specifically, to evaluate the supplementary losses presumably occurring in the spruce forest ecosystem. The second purpose (1985-1987) was to supply input-output hydrochemical budgets of these remote mountain watersheds (far from atmospheric pollution sources) that could serve as references to be compared with the hydrochemical budgets of similar basins in polluted areas, such as Aubure basin. The internal cycling of major chemical species was assessed by studying throughfall and soil waters. The biogeochemical reactions that take place during water transfer through the ecosystem were also identified. The results of the records from 1981 to 1986 enable the computation of annual hydrological budgets (incident rainfall-streamflow) and annual hydrochemical budgets (solute inputs-solute outputs). Overall, the biogeochemistry of the ecosystem is strongly influenced by the acidity of atmospheric precipitation, mainly in the spruce forest basin, suggesting the role of dry fallout. The mean annual sulfate fluxes supplied by wet bulk precipitation is nearly 20 kg S/ha-yr. This incident acidity is nearly completely neutralized in the soil by the cation mobilization and the sulfate retention. However, the more intense acidification in the spruce forest basin is marked by a release of sulfur. (Author's abstract)
W90-03952

LINKING NONPOINT POLLUTION AND DETERIORATION.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-03953

SOME NEW DEVELOPMENTS IN HYDROLOGICAL MODELLING.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
H. Boukes, and C. Maas.
Aqua AQUAAA, Vol. 38, No. 4, p 241-245, August 1989. 3 fig, 17 ref.

Descriptors: *Groundwater pollution, *Model studies, *Hydrologic models, *The Netherlands, *Groundwater pollution, *Nitrates, *Path of pollutants, Konikow/Bredehoeft Model, Boukwal Model, Mathematical models, Groundwater movement, Well fields, Performance evaluation, Solute transport.

With the growing threat of groundwater contamination, there also is a growing interest in modelling the groundwater system. Some new techniques used to calculate two-dimensional and three-dimensional groundwater flow are presented. Using the Konikow/Bredehoeft program, three scenarios for future nitrate concentrations in well fields in the Netherlands are presented: (1) with the actual manure deposition; (2) with restrictions as ordered by the new Soil Protection law; and (3) with even more severe restrictions. Although the Konikow/Bredehoeft program has limitations, when used judiciously it can give reliable predictions of the quality of the abstracted groundwater. In the southeastern part of the Netherlands, a well field called Vierlingsbeek is exploited by the Oost Brabantwater supply company. Before 1980 the nitrate concentration in the abstracted water was below 5 mg/l. The nitrate concentration in shallow groundwater in the surroundings of the well field exceeded 500 mg/l in some places. Because of problems with changing the Konikow/Bredehoeft program, a new program called Boukwal was developed; it is based on the principle of particle tracking but avoids some problems of the Konikow/Bredehoeft program. In the Boukwal model, every particle represents a fixed quantity of flowing water (5 cu m), particles are generated randomly in elements for which particles must be created, and the concentration of a new generated particle is directly linked to the element where the particle is created, and decay is modelled by giving a quantity of decay capacity to every element of the network. The model gave quite good results. To make a prediction for the whole well field, a three-dimensional version of the Boukwal program has been developed. The conversion from measurement to model input is being made and the first prediction using this program can be expected. (Rochester-PTT)
W90-03966

TRACE METALS IN THE DRINKING WATER OF BAHRAIN.
Hassan Ahmed Hassan Juma, Environmental Protection Committee, PO Box 26909, Bahrain.
For primary bibliographic entry see Field 5F.
W90-03972

STUDIES OF THE GROUNDWATER HAZARDS OF DEPOSITED FLY ASH FROM COAL-FIRED POWERPLANTS: PART II. INVESTIGATION OF ELUTION CHARACTERISTICS OF SOME MAJOR AND TRACE ELEMENTS FOR MULTIPLE EXTRACTIONS OF COAL FLY ASH UNDER VARIOUS SCENARIOS (ZUR UNTERSUCHUNG DER GRUNDWASSERGEFAHRDUNG DURCH ABGELAGERTEN FLUGSTAUB AUS STEINKOHLEKRAFTWERKEN: II. DAS AUSLAUGVERHALTEN EINIGER HAUPT- UND PURENELEMENTE VON FLUGSTAUB BEI MEHRFACHAUSLAUGUNGNEN FUER VERSCHIEDENE SZENARIEN).
Bremen Univ. (Germany, F.R.). Fachbereich Chemie/Biologie.
D. Spuziak-Salzenberg, and W. Thiemann.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 5, p 203-211, October 1989. 3 fig, 4 tab, 23 ref. English summary.

Descriptors: *Water pollution sources, *Fly ash, *Groundwater pollution, *Chemical analysis, *Heavy metals, *Trace elements, Pollutant identification, Elution, Lead, Aluminum, Silicon, Barium, Iron, Calcium, Magnesium, Arsenic, Boron, Selenium, Thermal powerplants.

In multiple elutions the rates of extraction of some major and trace elements of three coal fly ash samples were determined for various scenarios. Time behavior and resulting concentrations were analyzed. Pb, Al, Si, Ba, and Fe showed a rather small extraction together with stationary time behavior. Pb apparently was fixed into the glassy matrix. On the other hand, the elements Ca and Mg showed rather large extraction rates, up to 73%, which is due to the deposit of these elements as inorganic salts on the surface of fly ash particles. Such considerable mobilizations were observed also for the elements As, B, and Se. Under specific conditions, B as well as As were eluted in concentrations up to the mg/l range. (Author's abstract)
W90-04001

NITRATE AND AMMONIUM IN THE RHINE: CONCENTRATIONS, LOADS, TREND OF BEHAVIOR, AND ORIGIN, 1954-1988 (NITRAT UND AMMONIUM IM RHEIN - KONZENTRATIONEN, FRACHTEN, TRENDVERHALTEN UND HERKUNFT 1954-1988).
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
H. Hellmann.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 5, p 212-222, October 1989. 13 fig, 6 tab, 31 ref. English summary.

Descriptors: *Rhine River, *Germany, *Pollution load, *Water pollution sources, Temperature, Flow discharge, Ammonium, Nitrates, Seasonal variation, Water pollution effects, Time series analysis.

The results of measurements from 1954 to 1988 were evaluated for the Middle Rhine (catchment area: 110,000 sq km, 21 million inhabitants) taking the discharge and temperature conditions into consideration. The representative loads determined in this way serve for describing the trends of ammonium and nitrate nitrogen concentrations in the Rhine. On the basis of additional information, an attempt is being made to group the source regions for pollution loads according to their respective proportions of municipal and industrial sources and their share of the catchment area. The results are compared to those from other rivers in million tons/yr as follows: (1) the Rhine from Emmerich to Lobith had a nitrate load of 1.39 and an ammonium load of 0.034; (2) the Elbe River, 0.97 nitrate and 0.035 ammonium; and (3) the Weser and Ems Rivers, 0.35 nitrate and 0.004 ammonium. (Rochester-PTT)
W90-04002

INFLUENCE OF MATERIALS ON THE MICROBIOLOGICAL COLONIZATION OF DRINKING WATER.
Bonn Univ. (Germany, F.R.). Hygiene Inst.
D. Schoenen.
Aqua AQUAAA, Vol. 38, No. 2, p 101-113, April 1989. 16 fig, 3 tab, 57 ref.

Descriptors: *Water treatment, *Drinking water, *Microbiological studies, *Conveyance structures, *Bacterial analysis, Organic compounds, Microorganisms, Literature review, Substrates, Water quality control, Pipes.

Drinking water can be influenced intensively by materials with which it comes into contact. Materials with an organic base (coatings, films, sealants, plastic pipes and hoses) or with organic additives (cement mortar with organic compounds) can lead to an intensive growth of microorganisms. Field observations with bituminous and epoxy resin coatings, PVC-films, polyamide pipes and a plastic-containing cement mortar show, for example, that there is a considerable increase of microorganisms

in the water and a visible microbial growth upon the surface of the materials. In comparable investigations on some materials, growth could always be shown. This growth only developed on materials that liberate organic material such as solvents or plasticizers. Purely mineral products such as glass, enamel and cement mortar of metals, and also some plastic materials that do not release organic compounds, do not lead to an increase in microorganisms, although with the help of culture methods a microbial surface colonization can be established on these materials. To exclude deterioration of the drinking water it is necessary to examine materials before use--a test procedure is given. The growth of specific hygienically relevant germs, e.g. Legionella pneumophila, can be supported by materials, as demonstrated by investigations on pipes and hoses with water flowing through them. (Author's abstract)
W90-04008

HAND PUMP CORROSION IN DEEP BOREHOLES--A CASE STUDY ON IMPLEMENTATION OF GROUNDWATER SUPPLIES IN A DEVELOPING COUNTRY.
Interconsult A/S, Sandvika (Norway).
O. Haldorsen.
Aqua AQUAAA, Vol. 38, No. 2, p 114-117, April 1989. 5 fig, 5 ref.

Descriptors: *Corrosion, *Fouling, *Boreholes, *Test wells, *Well water, Pump wells, Deterioration, Water pollution sources, Steel, Water quality, Pipes, Water analysis, Iron, Zinc, Taste, Africa.

In 1980-1981, more than 300 deep boreholes in an African study area were equipped with handpumps most of which have rising mains and pump rods of galvanized steel. In the period 1985-1986, water from around 200 deep boreholes with handpumps was analyzed for iron. 48% had an iron content above the National Standard of 1.0 mg/L Fe, and about 30% contained more than 1.5 mg/L Fe. Only a few years after implementation, the corrosion of galvanized down-the-hole pump compounds are deteriorating the water quality to such an extent that the villagers are abandoning the boreholes and going back to their traditional sources. The underground galvanized steel pump components will probably have to be replaced by corrosion-resistant materials in most of the boreholes in the near future, or the wells may be rejected. Since a great number of handpumps currently manufactured for use in developing countries have galvanized steel rising mains, much more attention should be paid to water quality and the problem of corrosion. This is only possible if access to water laboratories is established and if the water quality findings are an integrated part in the decision making processes. (VerNooy-PTT)
W90-04009

EFFECT OF BROMIDE IONS ON TRIHALOMETHANE (THM) FORMATION IN WATER.
Institute of Public Health, Tokyo (Japan). Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 5F.
W90-04014

PHOSPHATE LOAD OF THE RIVER RHINE 1975-1986.
Unilever Research Lab., Vlaardingen (Netherlands).
A. L. De Jong, N. T. De Oude, A. H. Smits, and J. Volz.
Aqua AQUAAA, Vol. 38, No. 3, p 176-188, April 1989. 13 fig, 4 tab, 31 ref.

Descriptors: *Water pollution sources, *Rhine River, *Phosphates, *Detergents, *Pollution load, *Rivers, *Stream pollution, Path of pollutants, Data collections, Water pollution sources, Municipal wastewater, Regression analysis, Statistical analysis, Data interpretation, West Germany.

A survey of the main sources of P-emissions in the Rhine River during the past 15 years indicated that municipal waste water discharges account for approximately 60% of the P-load of the Rhine. Total P-emissions from municipal sewage in the catchment area were estimated for the period 1975-1976, taking into account factors like the increasing degree of sewage collection and treatment efficiency with regard to P-elimination, as well as changes in detergent consumption in households and detergent composition. The results of an intermediate study, whereby setup the gross and net phosphorus inhabitant equivalents and residual phosphorus load factors were calculated suggested a total reduction of P-emissions from municipal effluents between 1980 and 1986 by approximately 10,000 tons P/year. This coincided with the introduction of legislation restricting the P-content of detergents, reducing the load by approximately 6500 tons P/year. These findings were compared with the actual phosphate loads of the Rhine river from 1975 to 1986. Regression analysis of a modified data set established a good correlation between the reduction in detergent phosphate levels and the observed decline of the phosphate load in the river. A second statistical approach consisted of construction of a moderately complex Box-Jenkins model with two seasonal autoregressive operators and one moving average operator. Both statistical methods showed a decline of the average phosphate load of the Rhine in the same order of magnitude. The calculated net emission after sewage treatment was 17,800 tons P lower in 1986 than in 1975; the measured total phosphate load was about 10,000 tons P lower in 1986 than in 1975. It is estimated that about 6500 tons P of this load reduction was due to the reduced use of phosphate in detergents and that 3500 tons P can be attributed to improved sewage treatment. (Author's abstract)
W90-04015

PCB-POLLUTION PROBLEM IN THE UPPER HUDSON RIVER: FROM ENVIRONMENTAL DISASTER TO 'ENVIRONMENTAL GRIDLOCK'.
Barnard Coll., New York. Dept. of Geology.
J. E. Sanders.
Northeastern Environmental Science NOESDE, Vol. 8, No. 1, p 1-86, 1989. 30 fig, 14 tab, 311 ref, 2 append.

Descriptors: *Polychlorinated biphenyls, *Hudson River, *Liability, *Industrial wastewater, *Water pollution sources, *Legal aspects, New York, Path of pollutants, Water pollution effects, Stream pollution, Injunctive relief, Reviews, Rehabilitation, Detritus, Stream fisheries.

The PCB pollution of the upper Hudson River has been traced to two discharge pipes from capacitor-manufacturing plants of the General Electric Company (GE) at Hudson Falls and Fort Edward, located about 40 miles north of Troy, New York. In August 1974, EPA biologists carried out a field investigation upstream of, at, and downstream of the GE discharge pipes. In September 1975, goaded by articles about PCB-contaminated fish from the Hudson Estuary, the Commissioner of the New York State Department of Conservation (NYS DEC) commenced an administrative proceeding against GE, alleging violations of several NY State Environmental Conservation Law sections, and seeking cessation of PCB discharges, penalties for past discharges, and rehabilitation of the upper river. One stipulation of the resulting settlement agreement was that New York State 'sign off' with GE over PCB pollution of the Hudson River and, if the Advisory Committee recommended in favor of rehabilitation, it would use its 'best efforts' to find funds from 'sources other than GE' to help pay for rehabilitation. The Hudson River PCB Settlement Advisory Committee held its first meeting on 26 October 1976. Subsequently, the Committee became aware of the significance of remnant deposits (accumulated woody debris containing PCBs) in the PCB-pollution situation. In June 1978, the Advisory Committee recommended that DEC pursue upriver rehabilitation by dredging and that the sediments removed be securely encapsulated. The future of the PCB problem in the upper Hudson River seems likely to be settled by the outcome of a class-action lawsuit that commercial fisherman have filed against GE. In January 1989, a NEW York Appeals Court voted in favor of the ruling that the fishermen were entitled not only to payments for lost income, but to 'injunctive relief' (which implies that GE must clean up the River). (VerNooy-PTT)
W90-04026

NUTRIENTS AND PHYTOPLANKTON DISTRIBUTIONS DURING SPRING IN THE AEGEAN SEA.
National Centre for Marine Research, Athens (Greece).
For primary bibliographic entry see Field 2L.
W90-04027

CHARACTERIZATION OF THE ACCLIMATION PERIOD BEFORE ANAEROBIC DEHALOGENATION OF HALOBENZOATES.
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
T. G. Linkfield, J. M. Suflita, and J. M. Tiedje.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2773-2778, November 1989. 5 fig, 3 tab, 23 ref.

Descriptors: *Halogenated compounds, *Acclimatization, *Lake sediments, *Benzoates, *Biodegradation, *Fate of pollutants, Carbon, Anaerobic conditions, Microbial degradation.

The acclimation periods prior to detectable dehalogenation of halogenated benzoates in anaerobic lake sediments ranged from 3 weeks to 6 months. These acclimation periods were reproducible over time and among sampling sites and were characteristic of the chemical tested. The lengthy acclimation period appears to represent an induction phase in which little or no aryl dehalogenation is observed, followed by an exponential increase in activity typical of an enrichment response. Continuous growth from the time of the first exposure to the chemical is inconsistent with the extremely low per-cell activities estimated for the early days of the acclimation period and the fact that the dehalogenation yields no carbon to support microbial growth. The finding of a characteristic acclimation time for each chemical argues against nutritional deficiency, inhibition, or predation as an explanation for this phase of metabolism, while the reproducibility of the findings with time and space and among replicates argues against genetic changes as the explanation. The acclimation times did correlate with the eventual dehalogenation rates. This may reflect the general energy limitations in the anaerobic communities and suggests that those chemicals with faster dehalogenation rates provide more energy for the induction and growth phases of the active population. (Author's abstract)
W90-04028

NITRATE REDUCTION IN A GROUNDWATER MICROCOSM DETERMINED BY 15N GAS CHROMATOGRAPHY-MASS SPECTROMETRY.
Lund Univ. (Sweden). Dept. of Ecology.
G. Bengtsson, and H. Annadotter.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2861-2870, November 1989. 6 fig, 72 ref.

Descriptors: *Nitrates, *Groundwater pollution, *Denitrification, *Aquatic bacteria, *Microbial degradation, Fate of pollutants, Anaerobic conditions, Sand aquifers, Aerobic conditions, Biodegradation.

Aerobic and anaerobic groundwater continuous-flow microcosms were designed to study nitrate reduction by the indigenous bacteria in intact saturated soil cores from a sandy aquifer with a concentration of 3.8 mg NO3(-)-N/L. Traces of 15NO3(-) were added to filter-sterilized groundwater by using a Darcy flux of 4 cm/day. Both assimilatory and dissimilatory reduction rates were estimated from analyses of 15N2, 15N2O, 15NH4(+), and 15-N-labeled protein amino acids by capillary gas chromatography-mass spectrometry. N2 and N2O were separated on a megabore fused-silica column and quantified by electron impact-selected ion monitoring. NO3(-) and NH4(+) were analyzed as pentafluorobenzoyl

amides by multiple-ion monitoring and protein amino acids as their N-heptafluorobutyryl isobutyl ester derivatives by negative ion-chemical ionization. The numbers of bacteria and their (methyl-3H)thymidine incorporation rates were simultaneously measured. Nitrate was completely reduced in the microcosms at a rate of about 250 nanograms/gm/day. Of this nitrate, 80 to 90% was converted by aerobic denitrification to N2, whereas only 35% was denitrified in the anaerobic microcosm, where more than 50% of NO3(-) was reduced to NH4(+). Assimilatory reduction was recorded only in the aerobic microcosm, where N appeared in alanine in the cells. The nitrate reduction rates estimated for the aquifer material were low in comparison with rates in eutrophic lakes and coastal sediments but sufficiently high to remove nitrate from an uncontaminated aquifer of the kind examined. (Author's abstract)
W90-04032

OCCURRENCE AND CHARACTERISTICS OF AGGLUTINATION OF VIBRIO CHOLERAE BY SERUM FROM THE EASTERN OYSTER, CRASSOSTREA VIRGINICA.
Food and Drug Administration, Dauphin Island, AL. Fishery Research Branch.
M. L. Tamplin, and W. S. Fisher.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2882-2887, November 1989. 6 tab, 35 ref.

Descriptors: *Human pathogens, *Pathogenic bacteria, *Oysters, *Vibrio, *Path of pollutants, Aquatic bacteria, Salinity, Adsorption, Blood, Estuaries.

Cell-free hemolymph (serum) of the eastern oyster, Crassostrea virginica, agglutinated Vibrio cholerae an aquatic bacterium pathogenic to humans. Seventy-nine other strains of bacteria, including 14 genera and 26 species, were not agglutinated. The A, B, and C factors of O1 antigen were not involved in agglutination. Bacterial agglutinating (BA) activity was demonstrated for oysters inhabiting different environments of the U.S. Atlantic and Gulf coasts. Oyster serum BA titers showed high individual variation. The serum components involved in BA activity were inhibited by 80 C heat, pronase, EDTA, mucin, and fetuin treatments. N-Acetylneuraminic acid (10 mg/ml) weakly inhibited BA activity. Ligands of V. cholerae were sensitive to neuraminidase and resistant to 80 C and pronase. High salinities (24 and 30%) enhanced BA activity. Cross-adsorption tests with V. cholerae and human O+ erythrocytes indicated that BA and hemagglutinating activities may involve different serum components. These results imply that the ecology of V. cholerae in C. virginica is influenced by agglutinating activity of oyster serum. (Author's abstract)
W90-04033

SORPTION OF METALS TO BACILLUS SUBTILIS WALLS FROM DILUTE SOLUTIONS AND SIMULATED HAMILTON HARBOUR (LAKE ONTARIO) WATER.
Guelph Univ. (Ontario). Dept. of Microbiology.
I. T. Mayers, and T. J. Beveridge.
Canadian Journal of Microbiology CJM1AZ, Vol. 35, No. 8, p 764-770, August 1989. 4 fig, 3 tab, 27 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Bacillus, *Heavy metals, *Lake Ontario, *Sorption, Atomic absorption spectrophotometry, Chromium, Aluminum, Lake sediments, Polymers, Aquatic bacteria.

Purified cell walls of Bacillus subtilis were reacted with various metals in dilute solutions and a simulated Hamilton Harbour (Lake Ontario) water. Atomic absorption spectrophotometry revealed that iron was sorbed to the walls preferentially and caused the walls to adhere together to form macroscopic flocs, which were easily sedimented by gravity. Electron microscopy and energy dispersive X-ray analysis of the flocs showed that the bacterial walls were embedded in an iron matrix presumed to be iron oxyhydroxide. The sorption of iron to the walls also enhanced the uptake of other metals such as chromium and aluminum. This sorption suggests that bacteria may play a role in the initial formation of metal rich sediments. It may also have important implications for the general transport of metals to the sediments from the water column in fresh water environments like Hamilton Harbour by all types of particulate biological debris. (Author's abstract)
W90-04040

ATP-RELATED SPECIFIC HETEROTROPHIC ACTIVITY IN PETROLEUM CONTAMINATED AND UNCONTAMINATED GROUNDWATERS.
Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 5C.
W90-04041

ACID-SENSITIVE WATERS OF THE ENGLISH LAKE DISTRICT: A STEADY-STATE MODEL OF STREAMWATER CHEMISTRY IN THE UPPER DUDDON CATCHMENT.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
E. Tipping.
Environmental Pollution ENPOEK, Vol. 60, No. 3-4, p 181-208, 1989. 9 fig, 10 tab, 28 ref.

Descriptors: *Acid rain effects, *Water pollution sources, *Acid streams, *Lakes, *Model studies, *Water chemistry, *Acidic water, Hydrogen ion concentration, Weathering, Carbonates, Nitrogen compounds, Soil chemistry, Aluminum, Evapotranspiration, Sulfates, Carbon dioxide, Duddon River.

Data on deposition and streamwater chemistry, obtained for the upper catchment of the River Duddon (Cumbria, England) in the 1970s and 1980s, were reviewed. These data, together with soil chemical data, were used to deduce key processes in the deposition-catchment interaction, the analysis being based on current concepts of acidification. The processes were incorporated into a steady-state model that allows streamwater compositions to be calculated. The large baseflow pH range (5-7) of Duddon streams is accounted for in the model by a range of base cation weathering rates. Other processes invoked are evapotranspiration, the uptake of nitrogen by plants, dissolution of Al(OH)3 in the mineral soil, precipitation of Al(OH)3 in the baserock zone and in streamwater, Al3+ hydrolysis, and reactions of the carbonate system. Both cation exchange and sulfate adsorption are ignored, because they are assumed to influence rates-of-change between steady states, but not steady-state water compositions per se. The model can be used to estimate variations in streamwater composition with flow. Model calculations suggest that a 50% decrease in depositional acidifying components (sulfur oxides and NH4+) would result in increases of up to 1 pH unit in streamwaters with present-day baseflow pH values of 5 or less. It appears that water quality in the upper Duddon is currently more sensitive to inputs of NH4+ than of H2SO4. To improve the reliability of model predictions, more information is required on the pH dependence of base cation weathering, transformations involving nitrogen, aluminum chemistry and partial pressures of CO2 in soil and baserock. (Author's abstract)
W90-04042

EFFECT OF TWO APPLICATIONS OF ATRAZINE ON THE WATER QUALITY OF FRESHWATER ENCLOSURES.
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
For primary bibliographic entry see Field 5C.
W90-04045

ABIOTIC DEHALOGENATION OF 1,2-DICHLOROETHANE AND 1,2-DIBROMOETHANE IN AQUEOUS SOLUTION CONTAINING HYDROGEN SULFIDE.
Stanford Univ., CA. Dept. of Civil Engineering.
J. E. Barbash, and M. Reinhard.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1349-1357, November 1989. 1 fig, 4 tab, 55 ref.

Descriptors: *Fate of pollutants, *Organic compounds, *Hydrogen sulfide, *Chlorinated hydrocarbons, Kinetics, Phosphates, Chemical reactions.

To gain a better understanding of the fate of haloaliphatic compounds in oxygen-deficient natural waters, the dehalogenation of 1,2-dichloroethane (1,2-DCA) and 1,2-dibromoethane (EDB) in phosphate buffer alone, and in phosphate buffer containing hydrogen sulfide was examined. Kinetic runs were conducted at pH 7 over the temperature range from 25 to 87.5 C. Phosphate buffer catalyzed the hydrolysis of both 1,2-DCA and EDB. This catalysis was attributed to the buffer anion HPO4(--). The rate laws for these transformations and rate constants at 25 C are given. Results indicate that primary chloro-, and bromoalkanes are susceptible to abiotic dehalogenation by both H2O and HS(-) under conditions that are environmentally relevant. For the three nucleophiles examined, that is H2O, HPO4(--), and HS(-), the reactions with EDB at 25 C were found to be faster than those involving 1,2-DCA by factors of 13, 47, and 67, respectively. Furthermore, the rates of reaction with HS(-) at 25 C and pH 6 exceed the rates of reaction with H2O for total sulfide concentrations greater than 40 micromoles for EDB and 200 micromoles for 1,2-DCA. At 15 C and pH 6, the half-life of 1,2-DCA in 50 mM phosphate buffer is reduced from 170 to 23 yr when 1 mM total sulfide is present, while the addition of 1 mM sulfide to 50 mM phosphate buffer reduces the half-life of EDB from 16 yr to 160 days. (Geiger-PTT)
W90-04046

ENHANCED RETENTION OF ORGANIC CONTAMINANTS BY SOILS EXCHANGED WITH ORGANIC CATIONS.
Michigan State Univ., East Lansing. Dept. of Communication.
J. F. Lee, J. R. Crum, and S. A. Boyd.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1365-1372, November 1989. 5 fig, 4 tab, 23 ref.

Descriptors: *Water pollution treatment, *Soil contamination, *Fate of pollutants, *Ion exchange, *Organic compounds, Sorption, Soil texture, Soil water, Organic matter, Kinetics, Groundwater pollution.

The ability of soils to remove nonionic organic contaminants (NOCs) from water can be greatly enhanced by ion-exchange reactions of organic cations for natural inorganic exchange ions. Soils exchanged with organic cations of the form ((CH3)3NR)+ where R is a C9-C16 hydrocarbon, have significantly higher organic matter contents and display high sorptive uptake of common groundwater contaminants. Sorption coefficients (K values) of NOCs on hexadecyltrimethylammonium- (HDTMA-) treated subsurface soil increased by approximately 200 times. The K values for HDTMA-treated surface soils also increased significantly. When smaller organic cations, i.e., dodecyltrimethylammonium (DDTMA) and nonyltrimethylammonium (NTMA), were used, the exchange reactions were less complete, and the increases in organic matter contents and K values were less. Organic matter derived from the exchanged organic cations appeared to form an effective partition medium for NOCs. The organic phase derived from exchanged HDTMA was at least 10 times more effective than natural organic matter for removing NOCs from water; exchanged DDTMA was nearly as effective as HDTMA; however, NTMA was less effective. HDTMA was equally effective as a partition medium for NOCs when exchanged on soils of widely different textural classes. (Author's abstract)
W90-04047

PHOTOCATALYTIC DEGRADATION OF NONYLPHENOL ETHOXYLATED SURFACTANTS.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
E. Pellzzetti, C. Minero, V. Maurino, A. Sclafani,

and H. Hidaka.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1380-1385, November 1989. 8 fig, 1 tab, 26 ref. CNR, MPI, Enircerche, Regione Piemonte, E.S.O. Contract DAJA 45-85-C-0023. EEC Contract EV4V-0068-C(CD).

Descriptors: *Phenols, *Surfactants, *Photolysis, *Wastewater treatment, *Fate of pollutants, Kinetics, Model studies, Irradiation, Carbon dioxide, Dissolved solids.

Photocatalytic degradation of p-alkylphenols and the nonionic nonylphenol ethoxylate surfactants was studied using TiO2 particulates as photocatalyst. Degradation processes were monitored through liquid chromatography, CO2 evolution, dissolved organic carbon, and particulate organic carbon measurements. Complete conversion to CO2 was demonstrated. The degradation routes involve, in the early part of the process, a competitive attack of hydroxyl radicals on the ethoxy chain and on the aromatic ring, which can be rationalized in the framework of the kinetic model proposed. This research suggests that photocatalytic processes could be applied, together with other treatment of wastewaters, to ensure final disposal of undesirable products. (Geiger-PTT)
W90-04048

ATMOSPHERIC TRANSPORT AND DEPOSITION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Indiana Univ. at Bloomington. School of Public and Environmental Affairs.
B. D. Eitzer, and R. A. Hites.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1396-1401, November 1989. 5 fig, 4 tab, 35 ref.

Descriptors: *Chlorinated hydrocarbons, *Dioxins, *Dibenzofurans, *Path of pollutants, *Water pollution sources, *Deposition, *Air pollution, Washouts, Sediments, Fate of pollutants, Spatial distribution.

Atmospheric transport and depositional processes of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) were studied by determining their concentrations in ambient air and rain samples. Total concentrations in ambient air range from tens of picograms/cu m for urban locations to tenths of picograms/cu m for rural locations. The average total concentration in rain from a suburban area is 90 picograms/L. Comparison of the air and rain data gives washout ratio and Henry's law constant estimates. The total washout ratio ranges from 9,300 to 90,000, and the Henry's law constants range from .000015 to .000000090 atm-cu m/mol. Sediment fluxes compare favorably with those predicted from atmospheric concentrations. Comparisons of PCDD plus PCDF profiles with other environmental compartments show a consistent and systematic change from the combustion source profile to the sedimentary sink profile. (Author's abstract)
W90-04050

RETARDATION OF AMMONIUM AND POTASSIUM TRANSPORT THROUGH A CONTAMINATED SAND AND GRAVEL AQUIFER: THE ROLE OF CATION EXCHANGE.
Geological Survey, Denver, CO.
M. L. Ceazan, E. M. Thurman, and R. L. Smith.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1402-1408, November 1989. 7 fig, 41 ref.

Descriptors: *Fate of pollutants, *Ammonium, *Potassium, *Path of pollutants, *Aquifers, *Cation exchange, Sand aquifers, Sorption, Sediments, Calcium, Magnesium, Sodium, Nitrates, Tracers, Wastewater pollution, Groundwater pollution.

The role of cation exchange in the retardation of ammonium (NH4+) and potassium (K+) transport in a shallow sand and gravel aquifer was evaluated by use of observed distributions of NH4+ and K+ within a plume of sewage-contaminated groundwater, small-scale tracer injection tests, and batch sorption experiments on aquifer material. Both NH4+ and K+ were transported approximately 2 km in the 4-km-long contaminant plume (retardation factor, Rf = 2.0). Sediments from the NH4+-containing zone of the plume contained significant quantities of KCl-extractable NH4+ (extraction distribution coefficient, Kd(extr) = 0.59-0.87 ml/gm of dry sediment), and when added to uncontaminated sediments, NH4+ sorption followed a linear isotherm. Small-scale tracer tests demonstrated that NH4+ and K+ were retarded (Rf = 3.5) relative to a nonreactive tracer (Br-). Sorption of dissolved NH4+ was accompanied by concomitant release of calcium (Ca++), magnesium (Mg++), and sodium (Na+) from aquifer sediments, suggesting involvement of cation exchange. In contrast, nitrate (NO3-) was not retarded and cleanly separated from NH4+ and K+ in the small-scale tracer tests. The study demonstrates that transport of NH4+ and K+ through a sand and gravel aquifer can be markedly affected by cation-exchange processes even at a clay content less than 0.1%. (Author's abstract)
W90-04051

HYDROGEN PEROXIDE CONCENTRATION IN A NORTHERN LAKE: PHOTOCHEMICAL FORMATION AND DIEL VARIABILITY.
Florida International Univ., Miami. Drinking Water Research Center.
W. J. Cooper, and D. R. S. Lean.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1425-1428, November 1989. 2 fig, 1 tab, 41 ref.

Descriptors: *Water chemistry, *Rain, *Hydrogen peroxide, *Lakes, *Fate of pollutants, *Photochemistry, Degradation, Kinetics, Surface water.

Diel changes in hydrogen peroxide (H2O2) concentration in Jacks Lake, Ontario, suggested that photochemical processes were responsible for its formation. The concentrations of H2O2 reached 200-400 nanoM by late afternoon on a sunny day and declined to below 10 nanoM during the night. The depletion of H2O2 observed in near-shore lake sampling sites was faster than the dark decay rate of H2O2. The dark decay rate of H2O2 obeyed first-order kinetics and was much faster than those previously observed in marine environments. Rain was shown to have H2O2 concentrations up to 34 microM and may contribute to the surface water H2O2 concentration. (Author's abstract)
W90-04052

DISTRIBUTION OF COLLOIDAL ALUMINUM AND ORGANIC CARBON IN COASTAL AND OPEN OCEAN WATERS OFF NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
S. B. Moran, and R. M. Moore.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 10, p 2519-2527, October 1989. 3 fig, 6 tab, 48 ref.

Descriptors: *Path of pollutants, *Metal scavening, *Aluminum, *Organic carbon, *Colloids, Coastal waters, Radioactive tracers, Thorium radioisotopes, Seawater, Model studies, Particulate matter, Nova Scotia.

Cross-flow filtration has been used to study the size distribution of aluminum and organic carbon in an operationally defined colloidal size range (10,000 MW-0.45 microns; approximately 1-10 nanometers-0.45 microns) in coastal and open ocean waters off Nova Scotia. Colloidal aluminum was consistently < 5% of the dissolved (0.45 microns filtered) fraction by direct measure and 15% of dissolved Al by difference (0.45 microns filtered minus 1-10 nanometers filtered). Concentrations of Al measured in the colloidal fraction were high in the surface waters of the shelf, 0.44-0.55 nanoM (3-4% of dissolved), and decreased to levels of 0.09-0.15 nanoM (approximately 1% of dissolved) in deeper waters. The open ocean vertical distribution of colloidal Al was similar to that on the shelf, with elevated concentrations in surface waters, 0.16-0.19 nanoM (approximately 1% of dissolved), decreasing to 0.01-0.08 nanoM (0.5% of dissolved) in deep waters. Colloidal organic carbon was < 10-15% of dissolved organic carbon; however, the present organic carbon measurements may be underestimated by our analytical method which employs UV-photooxidation. Laboratory experiments, using Th234 tracer and several surface water samples, showed an increasing percentage of colloidal thorium from open ocean to nearshore waters; Th234 tracer was always slightly greater than Al in the colloidal size fraction. The relationship between the apparent distribution coefficient (K'd) for metals and particle concentration (Cp) for oceanic waters has been examined. Model predictions show that, for most of the global ocean, K'd will be independent of Cp. This result is in agreement with oceanic and laboratory K'd values determined for aluminum. (Author's abstract)
W90-04053

SEDIMENT BIOGEOCHEMISTRY OF IRON AND SULFUR IN AN ACIDIC LAKE.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 2H.
W90-04054

BIOGEOCHEMICAL FACTORS THAT INFLUENCE THE STABLE NITROGEN ISOTOPE RATIO OF DISSOLVED AMMONIUM IN THE DELAWARE ESTUARY.
Carnegie Institution of Washington, DC. Geophysical Lab.
For primary bibliographic entry see Field 2L.
W90-04056

BIODEGRADATION OF CRUDE OIL IN AN EXPERIMENTALLY POLLUTED PEATY MANGROVE SOIL.
Institut de la Carte Internationale du Tapis Vegetal, Toulouse (France).
For primary bibliographic entry see Field 5G.
W90-04058

CYCLIC ORGANOCHLORINES IN THE WHELKS BUCCINUM UNDATUM AND NEPTUNEA ANTIQUA FROM THE NORTH SEA AND THE IRISH SEA.
Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelschemie.
R. Knickmeyer, and H. Steinhart.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 433-437, September 1989. 4 fig, 2 tab, 24 ref. German Bundesminister fuer Forschung und Technologie contract MFU 0545/0.

Descriptors: *Path of pollutants, *Polychlorinated biphenyls, *Chlorinated hydrocarbons, *Mollusks, *DDE, *Bioaccumulation, North Sea, Irish Sea, Whelks, Fate of pollutants, Spatial distribution.

The body burdens of polychlorinated biphenyls (PCB), hexachlorobenzene (HCB), and p,p'-DDE in the whelks Buccinum undatum and Neptunea antiqua from the North Sea and the Irish Sea during early summer are reported. The patterns of individual PCB congeners were independent of the species, the size of the animals and the geographical origin. Hexachlorobiphenyls were the main congeners. Samples from the German Bight and the Liverpool Bay were more contaminated with PCBs compared to the central North Sea and the Irish Sea. Whelks from the Scottish east coast, the German Bight and the Liverpool Bay showed maximum amounts of p,p'-DDE in their tissues. The highest concentration of HCB was found at the Danish coast near Esbjerg. (Author's abstract)
W90-04059

GEOCHEMICAL ANOMALIES IN SEDIMENTS ON THE SHELF NEAR THE LAGOON OF VENICE, ITALY.
New South Wales Univ., Kensington (Australia). Dept. of Applied Geology.
A. D. Albani, P. C. Rickwood, V. M. Favero, and R. Serandrei Barbero.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 438-442, September 1989. 2 fig, 1 tab, 15 ref.

Descriptors: *Marine sediments, *Path of pollutants, *Venice Lagoon, *Geochemistry, *Italy, *Water pollution sources, Cadmium, Copper, Nickel, Vanadium, Sulfur, Phosphorus, Bottom sediments, Trace elements, Spatial distribution.

Evaluation of the geochemistry of the bottom sediments on the shelf near the Venice Lagoon was made by collecting samples with a modified Van Veen grab sampler at 174 sampling stations at intersections of a 1000 m grid. Results of trace element analysis performed by X-ray fluorescence spectrometry revealed localized concentrations of Cd, Cu, Ni, V, S, and, to a lesser extent, P. These elements are not known to be concentrated in the rocks within the catchment areas of the rivers that drain into the Lagoon and all distribution patterns indicate that they are not natural deposits. Dumped smelter waste and residues from tanning and plating industries seem to be possible sources of these pollutants. (Geiger-PTT)
W90-04060

FEEDING BEHAVIOUR AND MERCURY CONTENT IN TWO FLAT FISH IN THE NORTHERN TYRRHENIAN SEA.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. di Biofisica.
D. Pellegrini, and C. Barghigiani.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 443-446, September 1989. 4 fig, 1 tab, 19 ref.

Descriptors: *Path of pollutants, *Mercury, *Marine sediments, *Fate of pollutants, *Fish, *Mediterranean Sea, Fish behavior, Bioaccumulation, Fate of pollutants, Tissue analysis, Fish diets.

Total and organic mercury concentrations were determined in muscle tissue and stomach contents of specimens of Solea vulgaris and Lepidorhombus boscii, and in sediments collected in two zones (zone A and zone B) of the northern Tyrrhenian Sea affected by the presence of the cinnabar anomaly of Mt. Amiata. Relations of mercury concentration were studied with respect to length, age, sex, and feeding. No significant differences in mercury concentrations were observed between males and females in either species. The accumulation ratio increased with age in both species, but to a far smaller extent in sole. Mercury increase with length was significantly higher in L. boscii than in S. vulgaris. The mercury content of L. boscii was five times higher on the average than that of specimens of S. vulgaris of the same age. Data on stomach contents suggests that one cause of these differences was the different amount of mercury ingested in the diet. Although the mercury content of zone A sediments was higher (0.74 micrograms/gm Hg) than that of zone B (0.1 micrograms/gm Hg), they had the same percentage of organic mercury with respect to the total (< 1%). The mercury concentrations of the studied species did not reflect those of the sediments of the sampling zones. (Geiger-PTT)
W90-04061

INCREASED EUTROPHICATION OF THE NORTHERN ADRIATIC SEA.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
For primary bibliographic entry see Field 5C.
W90-04062

CONTAMINANTS IN BLUBBER, LIVER AND KIDNEY TISSUE OF PACIFIC WALRUSES.
Fish and Wildlife Service, Anchorage, AK.
D. L. Taylor, S. Schliebe, and H. Metsker.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 465-468, September 1989. 4 tab, 14 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Alaska, *Mammals, *Heavy metals, *Liver, *Kidneys, Lead, Cadmium, Zinc, Selenium, Mercury, Arsenic, Chlorinated hydrocarbon, Polychlorinated biphenyls.

Walruses from the spring harvest taken by Alaskan Natives from 1981 to 1984 were periodically monitored for levels of heavy metals, polychlorinated biphenyls and organochlorines in liver, blubber, and kidneys. Lead was present in 9 of 57 liver samples at a maximum concentration of 1.2 ppm. Concentrations were similar in liver (0.05 ppm) and in kidney (0.06 ppm). Lead was not detected in samples from Nome or from the Zakharovo collections. Cadmium occurred in all liver and kidney samples at maximum concentrations of 50 ppm in liver, and 99 ppm in kidney. Mercury occurred in all liver samples with a maximum concentration of 23 ppm. The maximum selenium concentration in liver was 12 ppm. Selenium in walrus kidney from Zakharovo samples averaged 0.5 ppm. Arsenic occurred in 6 of 57 liver samples at a maximum concentration of 0.15 ppm. Arsenic was not detected in samples collected at Nome, Diomede or Wales. In 13 liver samples, zinc averaged 44.61 ppm. The highest concentration of zinc was 75.0 ppm. Zakharovo kidney samples had an average concentration of 33.0 ppm zinc. Only dieldrin and oxychlordane were detected in blubber samples. Dieldrin was present in 14 of 53 samples at a mean concentration of 0 at Savoonga to 0.20 ppm at the Zakharovo. Oxychlordane was present in 11 of 53 samples. Mean concentrations varied from 0 at Wales to the highest level of 0.1 ppm in the Zakharovo samples. Eleven aliphatic hydrocarbon compounds were recorded in blubber tissue. Eicosanne and pristane occurred in concentrations > 1 ppm. (Geiger-PTT)
W90-04064

PESTICIDES AND PCBS IN OYSTERS FROM MAZATLAN, SINALOA, MEXICO.
California State Dept. of Fish and Game, Monterey. Marine Pollution Studies Lab.
M. Martin, and E. Gutierrez-Galindo.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 469-472, September 1989. 2 fig, 2 tab, 3 ref. California State Water Resources Control Board Interagency Agreement 7-018-250-0.

Descriptors: *Pesticides, *Fate of pollutants, *Oysters, *Halogenated pesticides, *Bioaccumulation, *Polychlorinated biphenyls, Estuaries, Chlorinated hydrocarbons, DDE, Insecticides, Agricultural runoff, Mexico, Mazatlan.

Adult oysters collected from the Estero de Urias (1.5 and 2.0 km southeast of the CFE fossil fuel thermoelectric plant, stations E3 and E4, respectively) near Mazatlan, Sinaloa, Mexico were analyzed for polychlorinated biphenyls (PCB), and pesticides in soft tissue by gas chromatography. The state of Sinaloa is very active in agriculture, and agricultural runoff of pesticides is a concern for public health. Only DDE and PCB (congener 101 + 153) were identified near the minimum reporting limits of the techniques. The two samples contained low concentrations of p,p'-DDE at 22 ppb and 18 ppb for the two sites, E3 and E4, respectively. Trace quantities of PCB congeners (101, 153) were detected in the 3-4 ppb ranges in both sample sites. All other pesticides were below the reporting limits. The concentrations of synthetic organic compounds (pesticides and PCBs) in resident oysters from Mazatlan Harbor were considerably lower than those found in bivalves along a majority of the California coast. (Geiger-PTT)
W90-04065

AMELIORATION OF STORM-WATER QUALITY BY A FRESHWATER ESTUARY.
Ohio Dept. of Natural Resources, Huron, OH.
For primary bibliographic entry see Field 2H.
W90-04078

ENVIRONMENTAL MICROBIOLOGY OF CHLORINATED AROMATIC DECOMPOSITION.
Harvard Univ., Cambridge, MA. Lab. of Microbial Ecology.
M. Boyle.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 395-402, October-December 1989. 1 fig, 2 tab, 107 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Microbial degradation, *Chlorinated hydrocarbons, Evolution, Adaptation, Plasmids.

The difficulty in predicting the microbial degradation rates of such xenobiotic chemicals as chlorinated aromatic hydrocarbons necessitates that empirical data on decomposition be collected to model the environmental fate and transport of these recalcitrant compounds. In natural systems a significant proportion of xenobiotic degradation involves cometabolism, a process in which the partial oxidation of a substance (primary degradation) is not accompanied by carbon incorporation or energy utilization by the degrading microorganisms. Extrachromosomal elements (plasmids) have been demonstrated to aid community adaptation to chemical stress. Work based on epidemiological studies of antibiotic resistance suggests that plasmids provide the genetic plasticity through which adaptive processes can work. Genes encoding for the metabolism of chlorobenzoates, PCBs and other xenobiotic compounds have often been shown to be located on plasmids. The improvement in the construction of microbial strains increases the possibility of managing the composition of degradative enzyme pools. If the appropriate genetic information can be introduced into robust microbial competitors, then the augmented enzymatic capacity could increase specific degradation rates. Areas with concentrated levels of xenobiotics, such as industrial waste ponds, landfills, chemical spills, and sewage treatment facilities, may provide the proving grounds for the next generation of microbial decomposers. Because chlorinated aromatic hydrocarbons were rare in the environment until a few decades ago, they provide a unique opportunity to study the evolution of multistep catabolic pathways for the degradation of compounds with novel chemical structures. (Mertz-PTT)
W90-04099

HEAVY METAL CONCENTRATIONS DURING TEN YEARS OF SLUDGE TREATMENT TO AN OLD-FIELD COMMUNITY.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
For primary bibliographic entry see Field 5E.
W90-04100

HERBICIDE LEACHING AND DISTRIBUTION IN TILLED AND UNTILLED SOIL.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
J. K. Hall, M. R. Murray, and N. L. Hartwig.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 439-445, October-December 1989. 3 fig, 2 tab, 18 ref. Department of Agricultural contract 82-CSRS-2-2057.

Descriptors: *Fate of pollutants, *Path of pollutants, *Pesticides, *Herbicides, *Leaching, Lysimeters, Atrazine, Simazine, Metolachlor, Cyanazine, Agricultural chemicals, Tillage.

Leaching and distribution of several pesticides, applied at recommended rates, were evaluated in a Hagerstown silty clay loam (Typic Hapludalf) by analyzing soil fractions and pan lysimeter percolates collected at a soil depth of 122 cm under conventional tillage and no-tillage corn management. In general, maximum herbicide concentrations detected and mean total amounts in pan lysimeter percolates were higher in 1985 than 1984 for both conventional tillage and no-tillage, and were greater under no-tillage conditions where more leachate was collected each year than in conventional tillage. Concentrations and amounts of simazine and atrazine were generally more substantial in pan lysimeter percolates than cyanazine and metolachlor acetamide, particularly under no-tillage conditions. In 1984, mean areal leaching losses (no-tillage) were 0.6% of applied rates for simazine and atrazine and 0.15% for cyanazine and metolachlor. In 1985, mean areal losses (no-tillage) were 3.4% for simazine and atrazine and 1.6% for cyanazine and metolachlor. Respective conventional tillage losses were less than 0.1% in 1984 and ranged from 0.4 to 1.0 % in 1985. Where worst-case conditions were considered (1985), mean leaching losses for simazine and atrazine were 0.15 kg/ha, therefore at least 91% (1.55 kg/ha) was retained and or degraded within the soil profile or

in the corn tissue after absorption. Soil core analysis corroborated pan lysimeter percolate results revealing that simazine and atrazine were the most persistent and mobile herbicides, and were consistently detected at all soil depths to 122 cm. Differences in the yearly extent and magnitude of leaching losses were related strongly to rainfall distribution and number of leaching events proximal to the herbicide spray date. (Author's abstract)
W90-04101

DECOMPOSITION OF HYDRAZINE IN AQUEOUS SOLUTIONS.
Florida Univ., Gainesville. Dept. of Soil Science.
A. M. Moliner, and J. J. Street.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 483-487, October-December 1989. 5 fig, 2 tab, 33 ref.

Descriptors: *Degradation, *Chemical degradation, *Fate of pollutants, Degradation products, Hydrazine, Chemical reactions, Laboratory methods.

The effects of several environmental factors on the fate of hydrazine in aqueous systems were studied under laboratory conditions. In aqueous systems, the primary mechanism of hydrazine degradation appears to be a four-electron oxidation to N2 gas by oxygen. The oxidation rate was very slow in distilled water but increased with the addition of catalysts such as Cu(II) and phosphate ions. Conditions that accelerated the formation of the hydrazyl radical, the first step in hydrazine oxidation, increased the proportion of one-electron oxidation. This resulted in increasing the formation of ammonia as one of the degradation products. Ammonia evolution was correlated with Cu(II) and phosphate ion concentrations, as well as with temperature. Hydrazine oxidation was primarily dependent on the rate of the oxygen diffusion from the gas phase. (Author's abstract)
W90-04106

COMPARISON OF TRACER MOBILITIES UNDER LABORATORY AND FIELD CONDITIONS.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
C. J. Everts, R. S. Kanwar, E. C. Alexander, and S. C. Alexander.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 491-498, October-December 1989. 7 fig, 4 tab, 34 ref.

Descriptors: *Path of pollutants, *Nonpoint pollution sources, *Tracers, *Groundwater pollution, *Pesticides, *Irrigation, *Water pollution sources, Bromides, Nitrates, Lithium, Tile drainage.

Transport of bromide, nitrate, lithium, and Rhodamine WT were compared in a repacked soil column and in a tile drained in a cropped field. Breakthrough of lithium and Rhodamine WT in a soil column was delayed by adsorption as compared to nitrate and bromide in the same column. When applied with irrigation water above a tile drain line, concentrations of all the tracers peaked in tile water 70 min after the start of an irrigation, then declined as irrigation continued. Tile flow responded to irrigation by increased flow and increased tracer concentration within 25 min after the start of an irrigation. Total percentage of tracers reaching tile flow from two tracer irrigations were 3.0% for nitrate, 2.5% for bromide, 0.46% for lithium, and 0.15% for Rhodamine WT applied with irrigation water. Of these losses, 67% of the cation-exchanged lithium and 83% the adsorbed Rhodamine WT removed in tile flow during 56 hours of tile flow did so within 1 hour after the irrigation ended. Proportion of nitrate losses in tile flow during the same time period were 40% and bromide losses were 35%. (Author's abstract)
W90-04107

HEXAZINONE PERSISTENCE AND MOBILITY OF A STEEP FORESTED WATERSHED.
Arkansas Univ., Fayetteville. Dept. of Agronomy.
T. L. Lavy, J. D. Mattice, and J. N. Kochenderfer.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 507-514, October-December 1989. 5 fig, 4 tab, 15 ref.

Descriptors: *Herbicides, *Path of pollutants, *Water pollution sources, *Pesticides, *Hexazinone, *Forest hydrology, Forest watersheds, Forest management, Runoff, Litter, Forest watersheds.

The mobility and persistence of the herbicide, hexazinone, applied to a forest floor with a spot-gun applicator was monitored for 43 months. A 15-m buffer zone separated the steeply sloping (40%) treated area from a continuously flowing stream directly below. Automated in-stream samplers revealed that the highest hexazinone concentrations in water routinely occurred during storm events, even when stream flow increased tenfold. More hexazinone ran off the treated watershed during winter months after tree leaves had fallen. During the first 24 months after treatment, 4.7% of total applied was detected in the stream sampled. Initially, forest litter was highly effective in adsorbing surface applications of hexazinone; however, after 5 months less than 0.2% of the original amount was retained in the litter. More than 99% of the hexazinone had dissipated from the top 30 cm of soil within 18 months after application. After 36 months, trace levels of hexazinone were detected in water samples collected soon after storms. However, no hexazinone was present in samples collected 43 months after application. Distribution coefficients for hexazinone adsorption revealed that this compound was retained most readily by the litter layer and decreasing adsorption was shown for soil deeper in the profile. Mean concentrations of hexazinone in green leaves of trees in the treated area ranged from 0.5 to 1.0/mg. Rapid dissipation of hexazinone in leaves lying on the floor suggested the possibility of recycling into existing vegetation. (Author's abstract)
W90-04108

BEHAVIOR OF AROMATIC SURFACTANTS AND PCBS IN SLUDGE-TREATED SOIL AND LANDFILLS.
Venice Univ. (Italy). Dept. of Environmental Science.
For primary bibliographic entry see Field 5E.
W90-04109

NITRATE CONCENTRATIONS IN RIVER WATERS IN THE SOUTH-EAST OF IRELAND AND THEIR RELATIONSHIP WITH AGRICULTURAL PRACTICE.
Regional Water Lab., Kilkenny (Ireland).
M. Neill.
Water Research WATRAG, Vol. 23, No. 11, p 1339-1355, November 1989. 11 fig, 6 tab, 20 ref, append.

Descriptors: *Agricultural watersheds, *Nonpoint pollution sources, *Nitrates, *Water pollution, *Path of pollutants, *Ireland, Seasonal variation, Ireland, Fertilizers, Water quality.

Nitrate concentrations in river waters in south-east Ireland are generally well below the permissible concentrations specified in the EC directives on the quality of water used or intended for human consumption. However, the advisory guide level has been exceeded on occasion in some rivers, mainly during winter when nitrate concentrations are highest. When river nitrate load (g/s N) was plotted against river flow in a log-log scale it was noted the better linear relationships were obtained when separate graphs were prepared for the November-April and May-October periods. Nitrate levels were significantly above normal in 1986, the very wet summers of 1985 and 1986 being the suspected cause as levels dropped again in 1987. Agricultural statistics showed a direct relationship between river nitrate concentrations and the percentage of land area ploughed in the river catchment. It was estimated that the mean nitrogen loss from land to rivers in the region was 2.0 kg/ha/yr N for unploughed land compared to 76 kg/ha/yr for ploughed land. (Author's abstract)
W90-04141

PHOSPHATE ADSORPTION BY DIFFERENT SEDIMENT FRACTIONS IN LAKE BALATON AND ITS PROTECTING RESERVOIRS.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 2H.
W90-04142

FATE OF 2,4-D IN MICROBIAL CULTURES.
Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-04150

BIOACCUMULATION OF LIPOPHILIC COMPOUNDS FROM SEDIMENTS BY OLIGOCHAETES.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
R. D. Markwell, D. W. Connell, and A. J. Gabric.
Water Research WATRAG, Vol. 23, No. 11, p 1443-1450, November 1989. 3 fig, 1 tab, 27 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Chlorinated hydrocarbons, *Bioaccumulation, *Oligochaetes, *Tubificids, Sediments, Interstitial water.

The bioaccumulation of lipophilic compounds from sediments by polychaetes has been considered as two partition processes at equilibrium. The first partition was considered to be between sediment and interstitial water and the second between interstitial water and the polychaete. Actual results from laboratory experiments on bioaccumulation of a range of chloro-hydrocarbons by Tubifex tubifex and Limnodilus hoffmeisteri from sediments were investigated using actual observed interstitial water concentrations, observed interstitial water concentrations corrected for the presence of colloids and interstitial water concentrations calculated from sediment concentrations. The bioconcentration factor values were calculated using the observed biotic concentrations together with the interstitial water concentrations except for the last situation listed where the biotic concentrations were corrected for not reaching equilibrium. The relationship obtained using interstitial water concentrations calculated from sediment concentrations and the corrected biota concentrations was log bioconcentration factor = 1.11 log octanol/water partition coefficient–1.0. This is believed to be the most accurate representation of the bioconcentration step and is in accord with that expected theoretically. It is suggested that this theoretical treatment and the currently available experimental data are in accord with a partition bioaccumulation process. (Author's abstract)
W90-04153

IONIC COMPOSITION OF VADOSE ZONE WATER IN AN ARID REGION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
R. C. Rice, R. S. Bowman, and H. Bouwer.
Groundwater GRWAAP, Vol. 27, No. 6, p 813-822, November-December 1989. 6 fig, 9 tab, 14 ref.

Descriptors: *Groundwater pollution, *Path of pollutants, *Nonpoint pollution sources, *Vadose water, *Arizona, *Irrigation effects, Salinity, Deserts, Urban runoff, Nitrates, Leaching, Land use.

The ionic composition of water in the vadose zone of the Salt River Valley in south central Arizona was studied for three different water regimes: desert, irrigated, and flooded by urban runoff. The desert area exhibited high salinity in the top 10 m, probably due to concentration of salts over several years. Below 15 m the salinity decreased with depth and approached the salinity of the native groundwater. For the irrigated area the chemical composition of the soil water was similar to that of the applied water but concentrations were higher. The irrigation efficiency calculated from the salinities of the irrigation and soil water was 78%. The average NO3 concentration from five of six sites was 100 mg/L, but was as high as 24,000 mg/L at another. Soil water from the urban runoff site had

an electrical conductivity that was about three times less than that from the irrigated site, showing the effect of leaching with rain water. The observed salt distributions in the vadose zone were reasonably correlated to land use at the sites sampled. (Author's abstract)
W90-04160

AEROBIC BIODEGRADATION OF BENZENE, TOLUENE AND XYLENE IN A SANDY AQUIFER--DATA ANALYSIS AND COMPUTER MODELING.
Shell Development Co., Houston, TX.
C. Y. Chiang, J. P. Salanitro, E. Y. Chai, J. D. Colthart, and C. L. Klein.
Groundwater GRWAAP, Vol. 27, No. 6, p 823-834, November-December 1989. 12 fig, 2 tab, 22 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Hydrocarbons, *Groundwater pollution, Benzene, Toluene, Xylenes, Dissolved oxygen, Microbial degradation, Model studies, Statistical analysis.

Soluble hydrocarbon and dissolved oxygen (DO) in a shallow aquifer beneath a field site were characterized by sampling groundwater at 42 monitoring wells. Results from 10 sampling periods over three years showed a significant reduction in total benzene mass with time in groundwater. These reduction and leakage rates from sources were determined from material balance and nonlinear least-squares analysis. The natural attenuation rate was calculated to be 0.95%/day. Spatial relationships between DO and total benzene, toluene, and xylene (BTX) were shown to be strongly correlated by statistical analyses and solute transport modeling. In addition, laboratory microcosm biodegradation experiments were performed to determine possible threshold limits for aromatic hydrocarbon oxidation under varying levels of dissolved oxygen. Groundwater hydrocarbon levels > or = 50 ppb were usually associated with DO concentrations of < 1-2 ppm. In addition, a DO of < 2 ppm may affect the biodegradation rate and persistence of BTX when hydrocarbons are present at > or = 100 ppb. The data also suggest that a minimum DO level (2 ppm) may be required for rapid biodegradation; however, the breakdown of hydrocarbons by sediment bacteria may also occur at lower DO concentrations but at slower rates. The results were remarkably consistent with field data on the presence of high or low levels of BTX and DO in several monitoring well-water samples. (Author's abstract)
W90-04161

WATER QUALITY MODEL CALIBRATION: A COMPARISON OF INPUT AND OUTPUT ERROR CRITERIA.
Research Triangle Inst., Research Triangle Park, NC.
K. W. Little, and D. T. Lauria.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 755-764, August 1989. 7 fig, 1 tab, 16 ref.

Descriptors: *Model studies, *Water quality, *Water resources data, Calibrations, Data processing, Error analysis, Monte Carlo method.

A common framework for the analysis of water resources systems is the input-parameter-output representation. The system, described by its parameters, is driven by inputs and responds with outputs. To calibrate (estimate the parameters) models of these systems requires data on both inputs and outputs, both of which are subject to random errors. When one is uncertain as to whether the predominant source of error is associated with inputs or outputs, uncertainty also exists as to the correct specification of a calibration criterion. Two alternative least squares criteria for calibrating a numerical water quality model were developed and analyzed. The first criterion assumes that errors are associated with inputs while the second assumes output errors. Statistical properties of the resulting estimators are examined under conditions of pure input or output error and mixed error conditions from a theoretical perspective and then using simulated results from a series of Monte Carlo experiments. The results show that each criterion preforms well when used appropriately, i.e., when the assumed error accurately reflects the true error. Under conditions of mixed errors, when neither criterion is strictly appropriate, neither criterion appears especially robust. Therefore, analysis of residual errors (predictions minus observations) should be performed after use of a particular calibration criterion to test whether the error assumption is reasonable. (Author's abstract)
W90-04172

MODEL FOR PREDICTING TRANSPORT OF PESTICIDES AND THEIR METABOLITES IN THE UNSATURATED ZONE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
U. S. Tim, and S. Mostaghimi.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 765-774, August 1989. 3 fig, 1 tab, 35 ref.

Descriptors: *Pesticides, *Pesticide residues, *Path of pollutants, *Fate of pollutants, *Model studies, Pesticide kinetics, Aldicarb, Simulation studies.

A finite element model based on Galerkin's upstream weighted residual technique was developed to predict the simultaneous convective-dispersion transport and transformations of pesticides and their metabolites in the unsaturated zone. Transformations of the parent compound and its metabolites were assumed to be first-order reactions for oxidation and hydrolysis, while adsorption of the pesticide species (parent compound and metabolites) to the soil components was assumed to be represented by a linear equilibrium (Freundlich type) isotherm. Volatilization and plant root uptake of pesticides in the solution phase were neglected in the analysis. The proposed model was used to simulate the transport and transformation of aldicarb and its metabolites, aldicarb sulfoxide and aldicarb sulfone, in the soil profile. Several examples are used to demonstrate the accuracy, validity, and applicability of the proposed model. Simulated results indicate that the proposed model can potentially be used to estimate the mass flux of water, and pesticides and pesticide metabolite concentrations in the subsurface environment. However, further verification of the model against actual field data is needed to fully demonstrate the model's potential. (Author's abstract)
W90-04173

ECONOMIC EFFECTS OF SOIL CONDITIONS ON FARM STRATEGIES TO REDUCE AGRICULTURAL POLLUTION.
Maryland Univ., College Park. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 5G.
W90-04179

EVALUATION OF SOME APPROACHES TO ESTIMATING NON-POINT POLLUTANT LOADS FOR UNMONITORED AREAS.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5A.
W90-04187

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLUME 3D AND UNCERTAINTY.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
W. Pettyjohn, and J. Wagner.
April 1984. 78p, 4 fig, 3 tab, 9 ref, 2 append.

Descriptors: *Geohydrology, *Path of pollutants, *Model studies, *Computer programs, *Groundwater pollution, *Groundwater movement, PLUME 3D model, UNCERTAINTY program, Computers, New York, Chromium.

Analytical solute transport models are highly idealized mathematical approximations of complex physical phenomena. However, if applied properly this class of models represents a useful tool for analyzing the transport and fate of substances under both field and laboratory conditions. A mathematical model (PLUME 3D) and an associated computer program (UNCERTAINTY) can be used to estimate concentration distributions in a leachate plume which emanates from a point source. The model includes both linear adsorption and first-order reactions. The computer program evaluates the analytical solution of the differential equation describing concentration distributions in a three-dimensional plume with uniform groundwater flow. The program has been designed for interactive use and requires input data under two models of operation--'Basic Input Data' and 'Edit.' Example problems are presented in this document based on the dispersal of chromium discharged to the groundwater is southeastern Nassau County, New York. (See also W90-04217 and W90-04218) (Lantz-PTT)
W90-04216

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLUME, CROSS-SECTION, AND RECHARGE.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
W. Pettyjohn, T. A. Prickett, and J. Wagner.
March 1984. 93p, 7 fig, 5 tab, 13 ref.

Descriptors: *Model studies, *Groundwater pollution, *Path of pollutants, *Computer programs, *Plumes, Groundwater recharge, Computers, Geohydrology, Leachates, PLUME model, PLUME CROSS-SECTION model, RECHARGE model.

Three computer models (PLUME, PLUME CROSS-SECTION and RECHARGE) have been designed to predict groundwater contamination and its possible effects. The models are written in BASIC and are designed for use on a microcomputer, such as an Apple, Kaypro, Compaq or similar unit. PLUME is a rather simple but very useful code that can be used to predict the concentration of a selected contaminant in a leachate plume at some point in space and time. Based on the same analytical solution, PLUME CROSS-SECTION allows an operator to examine the vertical concentration distribution in a leachate plume. Many groundwater and pollution studies require groundwater recharge as an input parameter. Recharge is the major cause of leachate formation, it forces a plume deeper below the water table, and tends to dilute the plume. RECHARGE is a method to estimate the regional rate and requires only streamflow data as input. (See also W90-04216 and W90-04218) (Lantz-PTT)
W90-04217

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLASM AND RANDOM WALK.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
W. Pettyjohn, and T. A. Prickett.
January 1984. 93p, 32 fig, 1 tab.

Descriptors: *Model studies, *Groundwater pollution, *Path of pollutants, *Computer programs, *Plumes, *Aquifers, Groundwater recharge, Computers, Geohydrology, Leachates, PLASM model, RANDOM WALK model.

Two computer models have been developed to evaluate groundwater flow problems and to predict the movement of contaminants through an aquifer. The models are written in BASIC and are designed for use on a microcomputer, such as an Apple, Kaypro, Compaq or similar unit. The models included in this manual are PLASM (Prickett-Lonnquist Aquifer Simulation Model), which is a groundwater flow model, and RANDOM WALK, a mass transport model based on PLASM. It is used to simulate the flow and removal of contaminants in an aquifer by means of several sources and sinks. (See W90-04216 thru W90-04217)(Lantz-PTT)
W90-04218

SUMMARY REPORT: A REVIEW OF INTERMEDIATE-SCALE EXPERIMENTS FOR SUBSURFACE MICROBIOLOGY AND CHEMISTRY.
Battelle Pacific Northwest Labs., Richland, WA.
G. P. Streile, J. K. Fredrickson, and J. M. Zachara.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-001750. Price codes: A03 in paper copy, A01 in microfiche. Report No. PNL-SA-16262, September 1988. 45p. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Path of pollutants, *Microbiological studies, *Research priorities, *Chemical analysis, Conferences, Detoxification, Hazardous wastes, Porous media.

A workshop sponsored by the US Department of Energy (DOE) and Pacific Northwest Laboratory (PNL) was held to determine: (1) whether intermediate-scale experiments on subsurface microbiology and chemistry could advance scientific understanding of contaminant transport processes in groundwater, and (2) the types of experiments that are needed at the intermediate-scale to advance the state of the art. The term 'intermediate-scale experiment' refers to an experiment that would be conducted in a system that is intermediate to the field and a laboratory batch reactor or column. Intermediate-scale research represents an approach to the investigation of the integrated effects of chemical, microbiologic, and hydrologic phenomena on contaminant transport in the subsurface that is different from field injection experiments. Intermediate-scale experiments may provide flexibility for hypothesis-driven research and an ability to use potentially hazardous organic and inorganic chemical mixtures relevant to the DOE mission. Moreover, a controlled, isolated system for the study of contaminant dynamics at the mesoscopic scale could also be used to evaluate remediation techniques for detoxification of soils and groundwater on DOE lands. There was consensus among participants that intermediate-scale research and an associated facility (or facilities) containing multidimensional flow cells are needed to resolve important subsurface research issues. PNL was urged to move forward with intermediate-scale experimentation incorporating university guidance and expertise where necessary. Most participants suggested that intermediate-scale experimentation should focus on: (1) the influence of controlled heterogeneity on chemical and microbiologic processes and their integrated effects, and (2) microbiologic processes at porous media interfaces or at the saturated/unsaturated zone boundary. (Lantz-PTT)
W90-04219

VIRGINIA'S GROUNDWATER.
For primary bibliographic entry see Field 2F.
W90-04221

UNDERSTANDING THE PROBLEM OF GROUNDWATER CONTAMINATION.
CorSTAR Research, Inc., Bethesda, MD.
L. R. Silka.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 5-17, 8 fig.

Descriptors: *Virginia, *Geohydrology, *Groundwater pollution, *Path of pollutants, *Water pollution sources, Aquifers, Groundwater movement, Geology.

The development of sound and rational programs to protect and clean up groundwater must be based on a clear understanding of the geohydrology and the transport mechanisms of potential contaminants. Groundwater protection strategies can best be implemented by considering the susceptibility of the aquifers and using siting procedures that minimize the potential impacts on the aquifers. Before allowing land use activities that are potentially harmful to groundwater, investigations should be conducted to determine the site's geohydrologic characteristics in Virginia's three geologic regions: Region I--coastal plain; Region II--Piedmont, triassic basins, and Blue Ridge; and Region III--valley and ridge. Groundwater flow directions, chemical transport processes, and heterogeneity in the system must be defined to gain as complete an understanding of the system as possible. Without this understanding, harmful land use activities may be permitted, monitoring programs may be ill-conceived, and remedial actions may be incorrectly designed. A groundwater protection program must encourage land uses compatible with the geohydrologic environment. (See also W90-04221) (Lantz-PTT)
W90-04222

STATE MONITORING PROGRAMS.
For primary bibliographic entry see Field 5G.
W90-04226

CONTAMINANT TRANSPORT FROM ELLIOTT AND COMMENCEMENT BAYS.
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-143267. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA 910/9-87-177, August 1987. 268p, 61 fig, 11 tab, 34 ref, 17 append.

Descriptors: *Water pollution sources, *Washington, *Path of pollutants, *Puget Sound, *Urban runoff, Elliott Bay, Commencement Bay, Sediment transport, Polychlorinated biphenyls, DDT, Polycyclic aromatic hydrocarbons.

Major sources of contamination to Puget Sound are concentrated in the urban embayments. Most of these contaminants are particulates or adhere to particles. If these particulates are dense, they tend to fall out of the water column near the sources; thus analysis of the sediment within urban embayments can provide an indication of the level of contamination, and by proximity, of the probable source of that contamination. During spring and summer 1985, and again in January 1986, a series of observations were made designed to determine to what degree contaminants in Elliott and Commencement Bays could leave the bays and enter the main basin of Puget Sound. The distribution of water properties (salinity, suspended particulate matter or SPM, and toxic trace metals and organics) were mapped during a period of high river runoff and during combined sewer overflow events after heavy rainfall. The dissolved contaminants, from whatever sources, remained in the very thin, fresh water plume and were transported through the bays and into the main basin quite rapidly; roughly five days in Elliott Bay and two days in Commencement Bay. The West Waterway is a source of high concentrations of dissolved trace metals, but not as high as from the Denny Way combined sewer overflow (CSO) and Harbor Island during periods of heavy rainfall. Directly beyond the sources, most of the suspended particulate matter remained in suspension in the fresh water plume. The high source strengths of the West Waterway and the Denny Way CSO were not unexpected. However, the runoff from the north end of Harbor Island during high rainfall was unanticipated but, in retrospect, not surprising. It should be determined if the concentrations are a function of ship-building activity. Polychlorinated biphenyls (PCB) and DDT isomers were undetectable in Elliott Bay and Commencement Bay water. Extremely high concentrations of polycyclic aromatic hydrocarbons (PAH) were measured near the Denny Way CSO and the Duwamish West Waterway, which is substantiated by findings of high PAH concentrations in the sediments at these locations. This study strongly suggests that, just beyond the sources, most of the contaminants entering these two bays enter the main basin quite rapidly. There is virtually no resuspension of sediments in Elliott Bay and relatively little in Commencement Bay, especially in water less than 100 m deep. (Lantz-PTT)
W90-04249

PREDICTION METHODOLOGY FOR CONTAMINANT TRANSPORT FROM RANGELAND WATERSHEDS.
Los Alamos National Lab., NM.
M. A. Devaurs, E. P. Springer, L. J. Lane, and G. J. Langhorst.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-014420. Price codes: A03 in paper copy, A01 in microfiche. Report No. LA-UR--88-2071, (1988). 25p, 11 fig, 3 tab, 22 ref. DOE Contract W-7405-ENG-36.

Descriptors: *Nonpoint pollution sources, *Model studies, *Path of pollutants, *Hydrologic models, *Watersheds, *Rainfall-runoff relationships, Sediment transport, Flood forecasting, Statistical studies, Floods, Plutonium.

A methodology is presented that uses stochastic weather generation in conjunction with hydrologic, erosion, and contaminant transport models to predict contaminant transport. Results are presented statistically to reflect the uncertainty in future weather patterns. Initial tests of the method revealed that flood frequency curves for two watersheds at Walnut Gulch near Tombstone, AZ, were underpredicted. The two hydrologic models tested produced similar results. Comparison of generated annual daily maximum precipitation values with 17 years of observed record found that the two maximum values in the observed record were not attained in the generated record. The inability to represent the flood frequency curve is a major limitation and must be remedied before this procedure is applicable. Further investigation of the statistical properties of generated weather data is needed. Apparently, hydrologic models such as used herein provide a logical tool to use in evaluating weather generators such as WGEN. The methodology was used to predict contaminant transport on the Plutonium Valley Watershed located on the Nevada Test Site. No comparison to observed data was possible. Parameter values for hydrologic and erosion models were obtained from rainfall simulator experiments conducted at the site. Predictions were made for current conditions and for a remedial action that removed 90% of the Pu contaminant but also removed vegetation and disturbed the surface soil. Fifty realizations were generated for each of the two conditions and results presented as probability plots. (Lantz-PTT)
W90-04253

AT INTENSIVE SURVEY OF THE SUGAR CREEK BASIN, CRAWFORD COUNTY, ILLINOIS, 1986.
Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
R. L. Hite, M. M. King, M. R. Matson, and C. A. Bickers.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-127807. Price codes: A04 in paper copy, A01 in microfiche. Report No. IEPA/WPC/88-030, July 1988. 81p, 11 fig, 18 tab, 28 ref, append.

Descriptors: *Watersheds, *Environmental quality, *Water pollution sources, *Water quality, *Illinois, *Industrial wastewater, *Municipal wastewater, *Water pollution effects, Sugar Creek, Macroinvertebrates, Fish, Environmental effects, Biological studies, Sediments, Stream biota, Aquatic habitats, Aquatic life.

An intensive survey of Sugar Creek and tributaries in the vicinity of Robinson, Illinois in Crawford County was conducted during the period June 24 to October 8, 1986. Sugar Creek, a tributary of the Wabash River, is 14 miles long and has a watershed of 69.5 sq mi. Major dischargers in the basin include the Robinson municipal wastewater facility (MWWTP) and the Marathon Oil Company refinery; both discharge to Robinson Creek. This survey was designed primarily to assess wastewater impact from these two sources upon water quality and biotic integrity of the receiving streams. Environmental quality was summarized utilizing various indices including water quality (WQI), macroinvertebrates (MBI), fish (AIBI), and habitat (PIBI). Individual stations were evaluated for degree of support of aquatic life and classified

according to the Biological Stream Characterization system used for Illinois streams. An assessment of chemical and biotic data collected in the Sugar Creek basin revealed slight to moderate stream quality impacts in a 1.7-mile reach of Robinson Creek downstream from the Robinson MWWTP. Severe stream degradation evident in approximately 9.5 miles of Robinson and Sugar Creeks was attributed to wastewater from the Marathon Petroleum Company. (Author's abstract)
W90-04254

SUPERFUND RECORD OF DECISION: INDUSTRIAL WASTE CONTROL, AR.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-04257

SUPERFUND RECORD OF DECISION: CHISMAN CREEK, VA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-04258

VOC CONTAMINATION AT SELECTED WISCONSIN LANDFILLS--SAMPLING RESULTS AND POLICY IMPLICATIONS.
Wisconsin Dept. of Natural Resources, Madison.
J. R. Battista, and J. P. Connelly.
Report No. PUBL-SQ-094 89, June 1989. 74p, 8 fig, 9 tab, 4 ref.

Descriptors: *Water quality control, *Water pollution sources, *Volatile organic compounds, *Wisconsin, *Landfills, *Waste disposal, Groundwater pollution, Solid wastes, Municipal wastes, Industrial wastes, Monitoring, Regulations.

The Wisconsin Department of Natural Resources, Bureau of Solid and Hazardous Waste Management (BSHWM) has completed the second part of a two part study to evaluate the need for routine volatile organic compound (VOC) sampling at Wisconsin landfills. This report summarizes the findings from this follow-up VOC study and the findings from a survey conducted on 48 states and two Canadian provinces on what type of VOC sampling they are requiring. These studies found that: (1) landfills with natural attenuation designs are more likely to have VOC contaminated groundwater than those designed with containment and leachate collection; (2) landfills taking municipal solid waste are more likely to have VOC contamination than those taking industrial solid waste; (3) landfills with waste volumes of < 50,000 cu yd are less likely to have VOC contamination than those with larger volumes; (4) VOC monitoring in other states and provinces ranges from no sampling requirements to quarterly sampling required at regulated landfill sites; and (5) inorganic parameters are useful in predicting VOC contamination. (Lantz-PTT)
W90-04270

LAND APPLICATION AND DISTRIBUTION AND MARKETING OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5E.
W90-04273

NATURAL FLUCTUATIONS OF WATER QUALITY IN A HEADWATER STREAM.
Ouachita Baptist Univ., Arkadelphia, AR. Dept. of Chemistry.
For primary bibliographic entry see Field 4C.
W90-04336

POLLUTION FROM URBAN AND INDUSTRIAL RUNOFF AND INSTREAM VARIATIONS IN WATER QUALITY.
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
J. V. Hunter.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 64-79, 2 fig, 8 ref.

Descriptors: *Path of pollutants, *Urban hydrology, *Water pollution control, *Water pollution sources, *Fate of pollutants, *Urban runoff, *Urbanization, *Water quality, Industrial wastewater, Hydrodynamics, Sediment transport, Sedimentation, Path of pollutants, Solute transport.

Analytical tools are available that can relate pollutant loads at their source to water quality downstream. Analytical methods are available for rivers, lakes, and for estuaries. Scientists are: best equipped to perform these analyses on dissolved oxygen and coliforms; fairly well equipped to evaluate impacts of pollutant loads on primary productivity in these waters; and, have the technology to make gross estimates of trophic level response of the aquatic ecosystem to the introduction of pollutant loads. Analysis capabilities are limited, however, by a lack of understanding of the following phenomena: the role of macrophytes in the nutrient cycle of streams (and lakes); hydrodynamic behavior of branched reservoirs and weakly stratified reservoirs; sediment movement in streams, lakes, and estuaries; coagulation-sedimentation processes that occur at freshwater-saltwater interfaces; the absorption-desorption mechanics controlling the attachment of pesticides, herbicides, heavy metals, and nutrients to suspended and settled sediments; and, the potential threat that these attached toxic materials pose to the aquatic environment as a result of ingestion by benthic animals and subsequently by the benthic grazers. Additional study and research in these areas will permit much better estimates of the impact of pollutant loads on receiving water quality. (See also W90-04338)(Lantz-PTT)
W90-04347

DATA GATHERING FOR STORMWATER RUNOFF AND SURVEILLANCE.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-04349

EFFECT OF POLLUTANTS ON BIOTA.
Michigan Dept. of Natural Resources, Lansing.
For primary bibliographic entry see Field 5C.
W90-04350

POLLUTION OF GROUNDWATER.
Princeton Univ., NJ. Water Resources Program.
R. W. Cleary.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 134-142, 11 ref.

Descriptors: *Urban areas, *Urban hydrology, *Water pollution control, *Groundwater pollution, *Groundwater quality, *Water pollution sources, Databases, Septic tanks, Land use, Land disposal, Water pollution treatment, Saline water intrusion, Model studies.

Groundwater is particularly important to urbanizing areas because it is frequently the major source of drinking water. Even in areas where surface supplies have traditionally been used, as these become contaminated with trace organics and other hazardous constituents, groundwater will become an attractive alternative. Counties, towns, small cities and suburbs of large cities have few technical guidelines and tools to assure that residential and industrial development occurs without unacceptable degradation of groundwater supplies. Databases for most groundwater pollution sources are nonexistent or inadequate. Among the unsolved groundwater problems of urbanizing areas, the following appear to be most urgent: (1) septic tank density distribution and its effect on groundwater quality; (2) land use and its effect on groundwater quality; (3) land disposal or application of industrial and domestic wastewaters; and (4) abatement procedures for contaminated aquifers--small communities are in need of guidance on clean-up and protection procedures for their water supplies. Some communities may also be concerned with saltwater intrusion problems, highway deicing salt problems, waste disposal well contamination, and agricultural pollution of groundwater. There is an urgent need for extensive field data, under diverse conditions, for all these groundwater quality problems. Procedures and guidelines are needed to advise growing communities how to sample their aquifers. As data collection and empirical experience increase there will be a need to generalize the results. Here computer modeling can play a very useful role. There is a need for more comprehensive models; coupled, multi-ion, chemical equilibria models will provide a realistic simulation of observed behavior. Without realistic models, data collection will be an endless, expensive task and planners will not be able to fully investigate all alternatives. (See also W90-04338)(Lantz-PTT)
W90-04353

DATA GATHERING FOR NPS AND ILLEGAL DISCHARGES.
Metropolitan Sanitary District of Greater Chicago, IL. Dept. of Research and Development.
For primary bibliographic entry see Field 7B.
W90-04358

METALS SPECIATION, SEPARATION, AND RECOVERY.
For primary bibliographic entry see Field 5D.
W90-04370

CHANGES IN METAL MOBILITIES IN AQUATIC AND TERRESTRIAL CYCLES.
Technische Univ. Hamburg-Harburg (Germany, F.R.).
U. Forstner.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 3-26, 10 fig, 2 tab, 88 ref.

Descriptors: *Path of pollutants, *Cadmium, *Trace metals, *Bioaccumulation, *Fate of pollutants, Toxicity, Chemical reactions, Particulate matter, Dissolved solids, Solubility, Molecular structure.

Changes in cycling, concentration and mobility of metals in the environment due to man can only be understood on the basis of global inputs. For describing typical mechanisms in trace metal cycling, and in particular those factors enhancing their mobility in both terrestrial and aquatic environments, cadmium was selected because of its toxicological importance. Significant factors considered are sources and critical pathways, dissolved and solid fractions of cadmium, and critical pools for Cd-mobilization in particulate matter. Both pH and redox changes in surface waters and soils can increase solubility, mobility and bioavailability of particle-bound metals. Geological and biological mobilization of elements, i.e., their energy-consuming transfer from sources to sinks, involves production of 'intermediates', which can act as useful or toxic substances for life. In general, an increase of metal input into an ecosystem will cause an increase of the metal content within the organisms. The bioavailability of a metal includes mechanisms such as absorption, transport to a site of metabolic/toxic activity, biotransformation to a metabolically active/toxic form, retention/accumulation, and excretion. The flux of a metal species is dependent upon physical, chemical and biological processes which can act as partial or almost complete barriers to the movement of an element along its pathways to man. Metal pollution in surface waters seems to have peaked in critical examples, mainly as a result of improvements in industrial wastewater treatment. These efforts should be strengthened with priority on the technologies applied near the source of pollution. (See also W90-04370) (VerNooy-PTT)
W90-04371

GENERAL AFFINITY CONCEPTS, EQUILIBRIA AND KINETICS IN AQUEOUS METALS CHEMISTRY.
California Inst. of Tech., Pasadena.
J. J. Morgan.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 27-61, 9 fig, 3 tab, 39 ref.

Descriptors: *Metal complexes, *Kinetics, *Chemical reactions, *Molecular structure, *Equilibrium, *Heavy metals, *Path of pollutants, Chemical treatment, Wastewater treatment, Water pollution, Cations.

Metal cycles on a regional and global basis have been profoundly modified by human activity. Hazardous metals, which existed in trace amounts in water (< 1 micromolar) under earlier, natural conditions, have been released to a greater and greater extent to aquatic and terrestrial aquatic systems. The speciation and fate of a metal in the natural environment, the biochemical action of a metal as nutrient to toxicant, and the effectiveness of control processes (separation, recovery, and recycle) are all ultimately to be understood and, eventually predicted on the basis of the electronic structures of the metal in coordination (Lewis acid-base) reactions with ligands, electron transfer reactions (redox), and free radical reactions. Classification of metals, behavior of metal cations in coordination compounds, transition metal complex stability, and aqueous acid-base reactions are discussed. Understanding the overall energetics of metal-ligands chemical reactions and oxidation-reduction reactions is one condition for predicting the actual behavior of metals in the environment and in engineering control systems. Energetic principles are also the basis of modern chemical theories of chemical reaction kinetics, principally the activated complex theory. Understanding the quantitative aspects of metals chemistry in the natural environment and in technological systems must ultimately rest on an understanding of the kinetics of slow versus fast reactions. But metals chemical kinetics can be extremely diverse and complex under the kinds of chemical conditions encountered in natural water systems and wastewater systems. Engineers and applied scientists can benefit from examples of successful applications of acid-base and redox chemistry in chemical analysis, biochemistry, geochemistry, soil chemistry, aquatic chemistry and other areas. (See also W90-04370) (VerNooy-PTT)
W90-04372

CURRENT STATUS OF METAL SPECIATION STUDIES.
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 2K.
W90-04377

ELECTROANALYSIS OF HEAVY METAL/ORGANIC MATTER SYSTEMS.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
R. F. M. J. Cleven, P. M. Wolfs, and H. P. van Leeuwen.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 243-259, 5 fig, 38 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Cadmium, *Lead, *Metal complexes, *Humic acids, *Bioavailability, *Fulvic acids, *Chemical analysis, *Electrochemistry, Decomposing organic matter, Particulate matter, Path of pollutants, Molecular structure, Polarographic analysis.

Heavy metals contaminating ecosystems are distributed over many species of different toxicity to biotic life. Metal speciation differentiates metal ions into fractions dependent on their physicochemical characteristics that may be related to bioavailability. Voltammetry is able to discern between free and complexed forms of a number of important heavy metal ions in a variety of matrices. To investigate the effects of the macromolecular nature of humic material on the voltammetric response to complexation with heavy metals, and the polyelectrolytic effect on the heavy metal/organic matter interaction, the systems Cd-Pb/fulvic acid-humic acid have been studied by normal pulse polarography (NPP), and the systems Cu-Pb/fulvic acid have been studied by square wave anodic stripping voltammetry (SWASV). Solutions of humic acid and fulvic acid at different degrees of neutralization, and thus different charge densities, have been titrated with heavy metal ions. The NPP results have been compared to those for similar titrations into solutions of poly(methylmethacrylic acid) (PMA), a linear polycarboxylic acid. In the voltammetric experiments, any polyelectrolyte effect will be partially suppressed due to the presence of 1:1 salt as supporting electrolyte. Therefore, a number of titrations into solutions of humic acid, fulvic acid, and PMA without supporting electrolyte have also been studied conductometrically. The results indicate that for low metal/ligand ratio the systems Cd-Pb/humic acid-fulvic acid are polarographically labile, and that a mean diffusion coefficient is operative controlling the NPP limiting currents. Both voltammetric and conductometric results provide evidence that polyelectrolyte effects play an important role in the interaction of cadmium and lead ions with organic matter ligands. (See also W90-04370) (VerNooy-PTT)
W90-04378

CHEMICAL INTERACTIONS BETWEEN HEAVY METAL IONS AND HYDROUS SOLIDS.
Delaware Univ., Newark.
For primary bibliographic entry see Field 5D.
W90-04383

FATE OF MICROBIAL INDICATORS AND VIRUSES IN A FORESTED WETLAND.
East Tennessee State Univ., Johnson City. Dept. of Environmental Health.
For primary bibliographic entry see Field 5D.
W90-04456

BIOLOGY AND CHEMISTRY OF GENERATION, PREVENTION AND ABATEMENT OF ACID MINE DRAINAGE.
Silver (Marvin) Scientific Ltd., Bedford (Nova Scotia).
M. Silver.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 753-760, 23 ref.

Descriptors: *Acid mine drainage, *Microorganisms, *Chemical reactions, *Water pollution treatment, *Wastewater treatment, *Heavy metals, Wetlands, Biological wastewater treatment, Macrophytes, Path of pollutants, Iron, Copper, Zinc, Manganese, Aluminum, Pyrite, Sulfides, Oxidation, Reduction, Sulfates, Precipitation, Humic acids.

The importance of microorganisms as catalysts in inorganic chemical reactions is recognized in commercial metal recovery and soil mineral transformations. Recently, the importance to the environment of microbially-mediated reactions has been documented. These reactions are described here including their relevance to the generation, prevention, and abatement of acidic drainage. Reactions involved in the solubilization and reprecipitation of polluting metals such as Fe, Cu, Zn, Mn, and Al also are discussed. These reactions include oxidation of iron sulfide minerals (mainly pyrite), oxidation of nonsulfide minerals (e.g., uranitite, siderite, and smithsonite), anaerobic oxidation of elemental sulfur and sulfur compounds, and jarosite formation by ferric iron hydrolysis. The three components of acid generation reactions are the mineral substrate, the oxidant, and the biological catalyst. Elimination of any one of these components will stop acid generation, but this is difficult to do in practice. Of the chemical, physical, and biological acid drainage abatement options, only those with a substantial biological component offer freedom from perpetual maintenance. Permanence depends on self-regenerative properties of biological systems that are integral functions of metabolism and interactions of all the components of these systems. Operational objectives of these systems are decreases in acidity through neutralization or sulfate removal and precipitation of metallic pollutants. Sulfate is removed from acid drainage by three mechanisms: reduction to sulfide, biological uptake, and formation of organic esters on plant decomposition products. Given an aerobic environment, pH > 5, and suitable organic substrates, sulfate-reducing bacteria reduce sulfate with pyruvic or lactic acids. Sulfides formed in these reactions may combine with heavy metals, leading to their precipitation as sulfides. Sulfate esterification in the presence of plant residues such as humic an fulvic acids, lignin, and cellulose appears to be mediated by microbes. Reactions that precipitate Mn may be enzymatic or nonenzymatic and remain poorly understood. (See also W90-04392) (Rochester-PTT)
W90-04468

WATER POLLUTION: PESTICIDES IN AQUATIC ENVIRONMENTS. JANUARY 1970-DECEMBER 1988 (CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5C.
W90-04484

ACID PRECIPITATION. SEPTEMBER 1987-DECEMBER 1988 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-853816. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 105 p. Supersedes PB87-866620.

Descriptors: *Bibliographies, *Acid rain effects, *Water pollution sources, *Acid rain, Literature review, Acidification, Rainfall, Precipitation, Water pollution control.

This bibliography contains 190 citations concerning the causes, effects, sources, and controls of acid precipitation and acidification. Techniques and technology for measurement and analysis of acid precipitation are considered. (See also W90-04488) (Author's abstract)
W90-04485

ACID PRECIPITATION. SEPTEMBER 1986-AUGUST 1987 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-853808. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 131 p.

Descriptors: *Bibliographies, *Acid rain effects, *Water pollution sources, *Acid rain, Literature review, Acidification, Rainfall, Precipitation, Water pollution control.

This bibliography contains 266 citations concerning the causes, effects, sources, and controls of acid precipitation and acidification. Techniques and technology for measurement and analysis of acid precipitation are also considered. (See also W90-04485) (Author's abstract)
W90-04488

LAND USE EFFECTS ON GROUND WATER QUALITY IN CARBONATE ROCK TERRAIN.
Arkansas Univ., Fayetteville. Dept. of Geology.
For primary bibliographic entry see Field 4C.
W90-04491

ESTIMATING POTENTIAL GROUND AND SURFACE WATER POLLUTION FROM LAND APPLICATION OF POULTRY LITTER.
Arkansas Univ., Fayetteville. Dept. of Agronomy.
J. T. Gilmour, D. C. Wolf, and P. M. Gale.
Arkansas Water Resources Research Center, Uni-

versity of Arkansas, Fayetteville, AR. Publication No. 128, June 1987. 36p. 11 fig, 4 tab, 28 ref.

Descriptors: *Water pollution, *Groundwater pollution, *Animal wastes, *Water pollution sources, *Land disposal, Poultry, Fertilization, Nitrogen cycle, Arkansas.

In 1985, more than 750 million broiler chickens were produced in Arkansas. During the same year over 15 million laying chickens produced 3.6 million eggs. The waste products of these agricultural production systems, poultry letter and manure, were about 1 million metric tons. As a result of land application of these wastes, about 5,000 metric tons of ammonium N and 12,000 metric tons of mineralized nitrogen were applied to Arkansas pastures in 1985. Manures contributed about 2-3 percent of the total. The objective of this research was to quantify major components of the nitrogen cycle which influence the ground and surface water pollution potential and the proper use of poultry or hen manure in a land application program. Both decomposition and N mineralization of representative samples of surface applied hen manure were evaluated. During the decomposition, N mineralization followed two patterns. Initially, N mineralization was rapid and the mineralized N plus initial inorganic N was converted to volatile ammonia and lost to the atmosphere. Later, one of two scenarios appeared to be operative. If nitrification and denitrification were small, then N immobilization likely occurred at a rate near that of N mineralization resulting in only small increases in inorganic N. Undigested feed was suggested as the immobilizing agent. If nitrification and denitrification were large, then N mineralization could have proceeded at expected rates and would not be measured by the methods employed herein. In a practical vein, the initial inorganic N and mineralized N in surface applied hen manure has a low N fertilizer value and water pollution potential due to volatilization of N. If the manure is incorporated or a rainfall event occurs soon after surface addition, more than 50 percent of the manure N could be available for plant uptake and contamination of ground and surface waters. (Author's abstract)
W90-04493

GROUND WATER POLLUTION: GENERAL STUDIES. FEBRUARY 1988-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB89-857098. Supersedes PB88-857016. Mar 89, 125p. Price codes: N01 in paper copy; N01 microfilm.

Descriptors: *Bibliographies, *Groundwater pollution, *Water pollution sources, *Path of pollutants, Literature review, Landfills, Mine drainage, Mathematical models.

This updated bibliography contains 207 citations concerning sources, contaminant transport, and monitoring of pollutants in aquifers. Topics include pollution characterization from landfills and mine drainage, descriptions of study programs undertaken by specific states, and superfund site studies of contaminated areas. The utilization of mathematical models is also discussed. Studies pertaining specifically to irrigation and pollution from fertilizers are excluded. All of the citations are new entries to the previous edition. (See also W90-04502) (Author's abstract)
W90-04497

POLYCHLORINATED BIPHENYLS: OCCURRENCE IN SEDIMENTS AND SOILS. JANUARY 1977-FEBRUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-855993. Price codes: N01 in paper copy; N01 microfilm. Supersedes PB88-857123. Prepared in cooperation with Office of Water Research and Technology, Washington, DC. Feb 89, 158p.

Descriptors: *Water pollution sources, *Bibliographies, *Polychlorinated biphenyls, *Sediment contamination, *Soil contamination, Literature review, Decomposition, Sorption, Dredging.

This bibliography contains 249 citations concerning field and laboratory analyses of polychlorinated biphenyls in sediments and soils. Topics include site studies, chemical analyses of adsorption-desorption processes, decomposition in soils, including biodegradation, and bioaccumulation. Detection methods and equipment, and the impact of dredging in contaminated areas are also discussed. Forty-twp citations are new entries to the previous edition. (Author's abstract)
W90-04500

GROUND WATER POLLUTION: GENERAL STUDIES. DECEMBER 1984-JANUARY 1988 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 2F.
W90-04502

5C. Effects Of Pollution

TOXICITY ASSAYS AND MOLECULAR STRUCTURE TOXICITY.
Drexel Univ., Philadelphia, PA.
R. E. Speece, N. Nirmalakhandan, and P. C. Jurs.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 36-66, 9 fig, 4 tab, 46 ref.

Descriptors: *Structure-activity relationships, *Environmental protection, *Water pollution effects, *Toxicity, *Bioassay, *Molecular structure, Laboratory methods, Literature review, Monitoring, Bacteria, Algae.

The complexity of a biological system's response to toxic chemicals suggests that it is overly optimistic to attempt to formulate a rational quantitative-structure activity relationship (QSAR) based upon molecular structure or gross properties. Furthermore, the different biochemical features of the multitude of bacteria found in the environment also suggest that it is overly optimistic to attempt to base a toxicity assay on any given pure culture, or even a mixed culture. Toxicity assays can provide valuable insight into the possible impact of chemicals released into the environment and they can also be used advantageously to give early warning indications for treatment processes. A growing battery of standardized and innovative assays can be used with varying levels of success. Among these are: Microtox, Algae, Protozoa, Daphnia, ISO, OECD, Spirillum volutans, Activate Sludge Respiration, Activated Sludge Dehydrogenase, Nitrobacter, BOD. If the idiosyncrasies of the various bacterial toxicity assays can be appropriately factored in, much qualitative information can be gleaned for various environmental purposes. (See also W90-03562) (Lantz-PTT)
W90-03565

ECOLOGICAL STUDIES IN THE MIDDLE REACH OF CHESAPEAKE BAY: CALVERT CLIFFS.
For primary bibliographic entry see Field 4C.
W90-03599

THERMAL AND OTHER DISCHARGE-RELATED EFFECTS ON THE BAY ECOSYSTEM.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 4C.
W90-03609

ENVIRONMENTAL STUDIES IN PORT VALDEZ, ALASKA: A BASIS FOR MANAGEMENT.
Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. 423p. Edited by David G. Shaw and Mohammad J. Hameedi.

Descriptors: *Water pollution effects, *Valdez, *Ecological effects, *Oil pollution, *Alaska, *Arctic zone, Ecosystems, Cycling nutrients, Phytoplankton, Zooplankton, Hydrocarbons, Monitoring, Information.

Studies of Port Valdez during the start-up and operation of the Alyeska Pipeline facility are among the most comprehensive ever done on a marine ecosystem. It is therefore appropriate that Port Valdez be used as a case study on the ability of present technology to detect significant ecosystem changes in an environment that is being subjected to a known level of disturbance--in this case the discharge of hydrocarbons into the environment. A number of general conclusions include: (1) it appears that no ecologically or socially significant biological changes have occurred that can be related to the ballast discharge; (2) even under favorable conditions, it is not possible to make a material balance between discharged oil and oil in the environment, after estimated degradation and adsorption rates are considered; (3) flushing of Port Valdez, and therefore nutrient input and cycling, are heavily influenced by storm patterns; (4) the energy producing regime--phytoplankton and macrophytes--and primary grazing regime--zooplankton and micronekton--changed dramatically between the before and after operation studies; (5) relatively little hydrocarbon contamination of the sediments is found in Port Valdez as compared to other oil contaminated regions; (6) compliance monitoring appears to have contributed little to detecting ecosystem changes since change due to natural disturbance and fluctuations far exceeded perturbations caused by the introduction of the contaminant; (7) a lack of basic understanding of the pelagic system has greatly reduced the ability to identify causative linkages between biological changes and specific disturbances; and (8) the assimilative capacity of Port Valdez does not appear to have been exceeded so that natural disturbances of this system still dominate the ecosystem and control community structure and function. (See W90-03611 thru W90-03625) (Lantz-PTT)
W90-03610

INTERTIDAL ZONE.
Alaska Univ., Fairbanks. Inst. of Marine Science.
H. M. Feder, and B. Bryson-Schwafel.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 117-164, 3 fig, 3 tab, 43 ref.

Descriptors: *Water pollution effects, *Oil pollution, *Intertidal areas, *Arctic zone, *Alaska, *Valdez, Monitoring, Clams, Mussels, Copepods, Barnacles, Algae, Bacteria, Prince William Sound.

Investigations of the intertidal environment of Port Valdez from 1975-83 provide the basis for a monitoring program. Species examined were the clam Macoma balthica, the blue mussel Mytilus edulis, the harpacticoid copepod Harpacticus uniremis, and the barnacle Balanus balanoides. A biological sampling program was developed to assess biological changes that might occur in the rocky intertidal during chronic low-level exposure to petroleum hydrocarbons derived from treated ballast water. On sediment shores, bacterial abundance values were relatively low, and populations showed a seasonal pattern with a density peak in August. Meiofaunal organisms were relatively diverse with representatives of nine phyla present. More than 90% of the meiofauna occurred in the upper 3 cm of sediment. Differences in meiofaunal composition appear related to the distribution of sediment types. The distribution, abundance, and zonation of plants and animals of the rock shores of the port were examined. The dominant species found throughout the year were the brown alga Fucus distichus, the blue mussel M. edulis, the periwinkle Littorina sitkana, and the barnacle B. balanoides. The few field experiments conducted on the effect of Prudhoe Bay oil on intertidal organisms are discussed. No significant differences in the size of

bacterial populations were reported after the experimental addition of crude oil to a sediment shore over a three-month period in the summer. Harpacticoid copepods were also not adversely affected by additions of crude oil to the sediment. However, chronic exposure to low-levels of oil concentration led to significant decreases in the viability of the sediment-dwelling clam M. balthica. Additional topics considered in this chapter are trophic interactions within the intertidal system, the effects of the 1964 earthquake within Prince William Sound on the intertidal system, a comparison of the Port Valdez intertidal with that of other northern systems, and environmental disturbance within the port. (See also W89-03610) (Lantz-PTT)
W90-03616

SUBTIDAL BENTHOS.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 2L.
W90-03617

FISHERIES RESOURCES.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
T. R. Merrell.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 203-224, 1 fig, 1 tab, 36 ref.

Descriptors: *Fisheries, *Fish populations, *Valdez, *Arctic zone, *Water pollution effects, *Oil pollution, Salmon, Alaska, Fish eggs, Fish hatcheries, Ecological effects, Wastewater disposal.

Pink, chum, and coho salmon and Pacific herring are the most important fisheries resources in Port Valdez from both commercial and recreational standpoints. Early life stages of these species are the most vulnerable to oil pollution: pink and chum salmon eggs in intertidal spawning streambeds, and fry during early marine life; coho salmon smolts during their seaward migration through Port Valdez; and Pacific herring eggs and larva during their first few weeks of life before they have dispersed away from spawning sites. The new Solomon Gulch Hatchery is expected to reach full production of salmon by 1989, when more than 6 million pink, 324,000 chum, and 60,000 coho salmon will return each year as adults. Most of the pink and chum salmon will be caught by common property commercial net fisheries, and most of the coho salmon by sport fishermen. Unless a catastrophic oil spill occurs in Port Valdez, or concentrations of toxic components from the treated tanker ballast effluent become substantially higher in Port Valdez than at present, it is unlikely that oil pollution will have significant adverse impacts on hatchery or natural stocks of salmon, herring, or other fishery resources. The possibility of eventual subtle indirect effects of hydrocarbons on salmon and herring, and their habitat, cannot be ruled out. Hydrocarbon concentrations from the ballast effluent are gradually increasing in sediment and water and could eventually have harmful effects, such as altering migratory behavior of juvenile and adult salmon, or diminishing the abundance of prey species upon which salmon and herring are dependent during early sea life. (See also W90-03610) (Lantz-PTT)
W90-03618

WATERBIRDS AND MARINE MAMMALS.
Fish and Wildlife Service, Anchorage, AK.
M. E. Hogan, and D. B. Irons.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 225-242, 2 fig, 3 tab, 37 ref.

Descriptors: *Water pollution effects, *Oil pollution, *Water birds, *Marine mammals, *Arctic zone, *Alaska, *Valdez, Waterfowl, Ecological distribution, Seasonal distribution, Annual distribution, Wastewater disposal, Otters, Seals, Ducks.

Accounts of waterbirds and marine mammals in Port Valdez are few and much of the available information is qualitative and pertains only to certain seasons of the year. Studies associated with the development of the pipeline terminal have yielded more detailed information on waterbirds and marine mammals in Port Valdez. The annual and seasonal distribution of these species is summarized. Port Valdez supports large, diverse populations of waterbirds and many sea otters and harbor seals. Protected bays and tidal mudflats are important habitats for birds. Sea otters gather in shallow areas to feed and harbor seals rest on shoreline rocks and ice floes from Shoup Glacier. Winter birds (alcids and sea ducks) and sea otters are most vulnerable to oil pollution. To date, there have been no devastating oil spills in Port Valdez and the effluent from the ballast water treatment plant has caused no known large scale mortalities of waterbirds or marine mammals. (See also W90-03610) (Lantz-PTT)
W90-03619

SUBLETHAL EFFECTS OF PETROLEUM ON BIOTA.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
J. F. Karinen.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 293-328, 1 fig, 4 tab, 78 ref.

Descriptors: *Water pollution effects, *Arctic zone, *Sublethal effects, *Oil pollution, *Valdez, Biological studies, Alaska, Hydrocarbons, Fish, Crustaceans, Mollusks, Naphthalene, Salmon, Larvae.

Recent reports describing sublethal effects and hydrocarbon concentrations measured in sediments, fish, crustaceans, and mollusks from various oil-impacted environments are reviewed, and compared to hydrocarbon levels in the environment of Port Valdez, Alaska. Concentrations of hydrocarbons having sublethal effects ranged from about 0.1 to 1 ppm for all species; all tests except two were with the hydrocarbons dissolved in water. The one test with oiled food and the rapid uptake of hydrocarbons by crustacean larvae provided important information with respect to evaluating the impact of continuous introduction of ballast effluent to Port Valdez. A rapid concentration of dissolved hydrocarbons by crustacean larvae may result in an equally rapid uptake by fish larvae and fry as they feed on these crustacean larvae. The concentration of 2-methyl-naphthalene (0.8 micrograms/g wet wt) in shrimp larvae after 1 hr exposure to extremely low concentrations (0.8 nanograms/ml) of this compound appears sufficient to cause effects on feeding and growth if these larvae were fed upon by pink salmon fry for an extended period (40 d). It is unknown whether fry in Port Valdez would be in the vicinity of oil-contaminated prey for this length of time, but these results show what is possible if circumstances are unfavorable for the salmon fry. Body burdens of this magnitude in the crustacean larvae may also make them more vulnerable as prey. Aromatic hydrocarbons in sediments, water, and biota of Port Valdez near the ballast diffuser are similar, in composition and concentration, to other oil impacted environments, and sublethal effects on biota of Port Valdez are probably detectable. (See also W90-03610) (Lantz-PTT)
W90-03622

HISTORICAL CHANGES OF THE RIVER WESER.
Wasserwirtschaftsamt Bremen (Germany, F.R.).
D. Busch, M. Schirmer, B. Schuchardt, and P. Ullrich.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 297-321. 9 fig, 8 tab, 65 ref.

Descriptors: *Weser River, *Water pollution effects, *History, *Channeling, *River training, *Ecological effects, Hydraulic engineering, Dikes, River regulations, Ecosystems, Invertebrates, Fish stocking, Fish populations, Environmental policy, Natural resources, Gravel, Management planning, Salts, Thermal pollution, Pollution load, Ships, West Germany, Navigation.

Diking, regulation, channelization, and pollution have caused a dangerous and critical situation for the River Weser (northern Germany) hydrosystem. The invertebrates have suffered a dramatic reduction. The fish stocks can only be maintained by extensive restocking efforts. The former river and valley landscapes, typical and richly structured, have been destroyed except in some small and localized areas. The number of factors inhibiting the potential renewal and spread of the fauna and flora are immense. The environmental laws of the 1980s concerning protection of the remaining natural resources from further destruction by human activities, only prescribe compensation for newly planned activities. Some steps to compensate for the channelized and regulated river have already occurred at gravel-lakes all along the Weser. A real change requires the implementation of a coordinated program to restore local river and valley regions, combined with drastic effluent reductions in salt, heat, and other pollutants and a switch to different ship types with less wake and swell, or even a ban on big ship traffic along the Weser. Only by these measures might some of the remaining ecological qualities of the Weser be saved. (See also (W90-03689) (Fish-PTT)
W90-03706

FISH AS SENTINELS OF ENVIRONMENTAL HEALTH.
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
For primary bibliographic entry see Field 5A.
W90-03743

RELATIONSHIP OF ESTUARINE PLANT CONTAMINANTS TO EXISTING DATA BASES.
European Research Office, London (England).
F. S. Henriques, and J. C. Fernandes.
Available from the National Technical Information Service, Springfield, VA 22161, as ADA-201 725. Price codes: A04 in paper copy, A01 in microfiche. Final Technical Report, February 1988. 69p, 5 fig, 16 tab, 45 ref, 8 append. US Army Contract DAJA 45-87-C-0001.

Descriptors: *Water pollution effects, *Portugal, *Aquatic plants, *Estuaries, *Sado River, *Path of pollutants, Sediment contamination, Copper, Bioaccumulation, Heavy metals, Lead, Salt marshes, Databases, Oak trees.

A field survey was conducted to assess the pollution levels in plants, sediments and waters of the Sado River basin (in the south of Portugal), an area thought to be contaminated with mine effluents and industrial discharges. Field sampling was carried out in the Sado estuary, where sediments and Halaimione portulacoides (a salt marsh species) were collected. In the upper zone of the Sado basin, near the pyrites mines of Aljustrel and Lousal, holm-oak and rush plant materials were collected, as well as soil and water samples. Although Sado estuary sediments presented relatively high levels of Cu, the plants did not reveal signs of metal accumulation--their Cu contents were similar to those found on control plants from uncontaminated salt marshes of the Miro River estuary, and to those reported in the literature for uncontaminated plants. Holm-oak trees growing near the pyrites mines presented high heavy metal contents in the leaves and acorns. Metal accumulation in acorns poses a serious health hazard, because these fruits are consumed by local population. Pb levels in acorns are particularly worrying. Holm-oak growing on an effluent ditch at Lousal mines revealed remarkable adaptations to heavy metal stress. Apparently, the plant was capable of tolerating the extremely high metal concentrations in the sediment, through prevention of metal translocation from the roots to the shoot. (Author's abstract)
W90-03765

AGRICULTURAL PRACTICES: POLICY IMPLICATIONS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biolog-

ical Engineering.
K. S. Porter.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 47-65, 8 fig, 8 tab, 10 ref.

Descriptors: *Water pollution sources, *Water pollution control, *Agricultural runoff, *Public policy, *Farm wastes, *Water pollution effects, *Management planning, Groundwater pollution, Nonpoint pollution sources, Long Island, Agricultural chemicals, Groundwater quality, Water law, Economic aspects, Resources management, Regulations.

Agricultural practices can seriously affect the quality of groundwater. Intensive units used for animal production, such as beef feed lots, produce large volumes of concentrated wastes which may, if unmanaged, contaminate groundwater. These wastes, however, are generally capable of treatment and disposal as point sources, and technology ensuring sound wastewater management has been fully developed. Problems of groundwater pollution due to agricultural point sources are then more likely to be economic rather than technical. This paper discusses the more subtle and controversial problem of agricultural nonpoint sources of groundwater contamination. Nonpoint sources are not amenable to direct measurement, by definition, especially when considering large areas. A considerable effort is now being made nationwide to determine the relative importance of agricultural and other nonpoint sources of contaminants. Under Section 208 of the Federal Water Pollution Control Act Amendments of 1972, management programs must be developed which specifically include agriculture. One of the largest such programs in the nation is currently being developed for the Nassau-Suffolk region of Long Island. This paper briefly outlines those parts of the program which are attempting to assess the impact of agricultural chemicals on groundwater. The specific objectives of the study are: (1) to estimate the use of agricultural chemicals in Nassau and Suffolk Counties; (2) to assess the impact of such use on groundwater; and (3) to develop appropriate management and public policies. (See also W90-03771) (Lantz-PTT)
W90-03779

METHODOLOGY FOR EVALUATING THE ENVIRONMENTAL AND PUBLIC HEALTH RISKS OF CONTAMINATED SOIL.
McLaren Environmental Engineering, Inc., Alameda, CA.
D. J. Paustenbach.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 225-261, 2 fig, 9 tab, 152 ref.

Descriptors: *Environmental effects, *Public health, *Soil contamination, *Hazardous wastes, *Risk assessment, Evaluation, Pesticides, Wildlife, Vegetation, Standards, Organic compounds.

Millions of yards of soil throughout the United States have been contaminated with numerous types of liquid and solid wastes containing metals, radioactive materials, gasoline, solvents, used oils, and sludges. The potential environmental hazards due to contamination of runoff water and pollution of groundwater, as well as the possible adverse effects on biota, fish, and wildlife, have been studied for a number of years. Although the health hazards of living close to a hazardous waste site have been a concern during much of the past 10 years, in the main, epidemiology studies have not shown that these sites produce adverse health effects in humans who live near them. Certainly, under some circumstances, direct contact with soil contaminated with sufficiently high levels of particular toxicants could present a hazard to humans and wildlife, but such situations appear to be uncommon. Exposure to contaminated soil can occur through skin contact, inhalation, or ingestion. Although some have claimed that it is difficult or impossible to estimate--either prospectively or retrospectively--the dermal, inhalation, and oral uptake of chemicals to which humans have been exposed in the environment or at work, there appears to be little basis for these claims. It is true that there will be varying degrees of uncertainty in the estimates of likely exposure. In an attempt to evaluate the magnitude of the health hazard, estimates of exposure have been made for: (1) pesticide applicators; (2) children exposed to lead via dust and dirt; (3) workers exposed to vapors and dusts; (4) vegetation, wildlife, and humans exposed to nuclear fallout; (5) persons involved in accidental chemical releases; and (6) those exposed in Vietnam. Each of these studies contains information which is valuable for developing exposure estimates for nearly any situation. Specific physical physiological, and chemical parameters needed to estimate the uptake of a given chemical present on contaminated soil were evaluated with special emphasis placed on the risk assessments of tetrachlorodibenzo-p-dioxin (TCDD) contaminated soil conducted by the Centers for Disease Control and the EPA. These studies have become the benchmarks against which other assessments of contaminated soil are compared. (See also W90-03830) (Lantz-PTT)
W90-03846

REVIEW OF PRESENT RISK ASSESSMENT MODELS FOR PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Div. of Nursing.
P. T. Kostecki, E. J. Calabrese, and H. M. Horton.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 263-300, 2 fig, 9 tab, 7 ref.

Descriptors: *Risk assessment, *Soil contamination, *Oil pollution, *Environmental effects, Toxicity, Population exposure, New Jersey, California, Washington, Underground storage, Model studies, Superfund, Absorption, Bioaccumulation.

Seven risk assessment methodologies were evaluated as a preliminary means of developing a risk assessment methodology that can be applied to petroleum contaminated soils. By determining the strengths and weaknesses of these methodologies, a stronger risk assessment process can be developed. A risk assessment methodology should include variables which clearly represent the hazard level, exposure level, and the level of risk at a particular site. Criteria used to assess the strengths and weaknesses of the hazard, exposure, and risk analyses are: (1) hazard analysis--derivation of toxicity values, noncarcinogenic acute toxicity, noncarcinogenic chronic toxicity, carcinogenic chronic toxicity, assessment of mixtures, body weight factor, pharmacokinetic factors; (2) exposure analysis--air inhalation, dust inhalation, water ingestion, soil ingestion, dermal absorption, crop uptake, livestock uptake, fish uptake, environmental fate, half-life factor, site-specific factors; and (3) risk analysis--additivity of the hazard level for chemicals having common toxic effects, additivity of the hazard level for multimedia exposure, and synergistic effects. Seven methodologies are reviewed and include: the California Site Mitigation Decision Tree; EPA Superfund; New Jersey Method; the State of Washington Cleanup Policy; and, California's Leaking Underground Fuel Tank (LUFT) Field Manual. Each methodology is described and critically evaluated. A summary table follows each methodology along with a final tabular summary, directly comparing each of the seven methodologies. (See also W90-03830) (Lantz-PTT)
W90-03847

SUPERFUND EXPOSURE ASSESSMENT MANUAL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5B.
W90-03849

IN SITU MEASUREMENTS OF TOTAL REACTIVE NITROGEN, TOTAL WATER, AND AEROSOL IN A POLAR STRATOSPHERIC CLOUD IN THE ANTARCTIC.
National Oceanic and Atmospheric Administration, Boulder, CO. Aeronomy Lab.
For primary bibliographic entry see Field 2B.
W90-03901

OCCURRENCE OF TRI-N-BUTYLTIN-CAUSED IMPOSEX IN THE NORTH PACIFIC MARINE SNAIL NUCELLA LIMA IN AUKE BAY, ALASKA.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Fisheries Lab.
J. W. Short, S. D. Rice, C. C. Brodersen, and W. B. Stickle.
Marine Biology MBIOAJ, Vol. 102, No. 3, p 291-297, September 1 1989. 3 fig, 2 tab, 20 ref.

Descriptors: *Antifoulants, *Snails, *Organotin compounds, *Imposex, *Pesticides, *Water pollution effects, *Sublethal effects, *Population exposure, *Toxicity, *Bioindicators, Organic compounds, Alaska, Bioassay, Bioaccumulation, Mollusks.

Like female dog whelks (Nucella lapillus) in the Atlantic Ocean, females of the Pacific gastropod N. lima respond to low concentrations of tri-n-butyltin (TBT) by growing a penis and vas deferens. This condition, termed imposex, was found to occur in N. lima collected from August 1987 to May 1988 along a TBT pollution gradient associated with a marina in Auke Bay, Alaska. The suite of symptoms characteristic of imposex in N. lima was slightly different than in N. lapillus. Imposex, as measured by relative penis size (RPS) of females to males, increased from 0.0 to 34.27 along this gradient and as measured by vas deferens sequence-index (VDS) increased similarly from 0.0 to 4.29. Concentrations of TBT in N. lima increased from below detection limits (about 0.010 micrograms Sn/g dry tissue wt) to 0.065 micrograms Sn/g dry tissue wt along the gradient. The gradient was determined by measuring TBT in whole-body tissues of bay mussels (Mytilus edulis). Concentrations of TBT in mussels increased from below detection limits to 0.833 micrograms Sn/g dry tissue wt in mussels from within the marina that was the major local source of TBT. Imposex, tissue TBT burden, and position along a TBT pollution gradient are significantly correlated ($p < 0.01$) in N. lima. TBT was tested as a causative agent for imposex by exposing snails at a distant control site to TBT paint. After 1 mo exposure, 33% of the females grew a penis ranging in size from 0.2 to 0.8 mm. The results generally corroborate those found for N. lapillus and indicate that imposex in N. lima is caused by environmental TBT exposure. It is suggested that the RPS in the genus Nucella may be useful in monitoring TBT in coastal waters worldwide. (Author's abstract)
W90-03917

POPULATION-RELATED TOXICITY RESPONSES TO TWO BUTYLTIN COMPOUNDS BY ZOEAE OF THE MUD CRAB RHITHROPANOPEUS HARRISII.
California Univ., Oakland. Naval Biosciences Lab.
R. B. Laughlin, and W. French.
Marine Biology MBIOAJ, Vol. 102, No. 3, p 397-401, September 1 1989. 4 fig, 1 tab, 20 ref.

Descriptors: *Pesticides, *Antifoulants, *Organotin compounds, *Water pollution effects, *Population exposure, *Toxicity, *Sublethal effects, *Crabs, *Dose-response relationships, Organic compounds, Crustaceans, Teratogenic effects.

Zoeae of the mud crab Rhithropanopeus harrisii were exposed to either bis(tri-n-butyltin) oxide (TBT) or di-n-butyltin dichloride (DBT). Experiments were repeated with zoeae from females collected from the Petaluma River, California in June-August 1983 and 1984 or from Sykes Creek, Florida in February 1985. Using probit analysis, LC50 values were calculated for exposure lasting the duration of zoeal development. Tributyltin was 54 to 65 times more toxic than dibutyltin, the lower value characterizing the response of Florida zoeae. Increases in duration of zoeal development and reduction of dry weights of megalops, both sublethal responses, were dose-dependent for the two

populations. However, zoeae from Florida consistently had shorter duration of zoeal development and higher megalopal weights at metamorphosis, indicating less sensitivity to an identical exposure to either organotin compound. The results of these experiments show that dibutyling, a putative degradation product of tributyltin, is less toxic than the parent compound. In addition, early life-history stages of two populations may have significantly different responses to xenobiotic stress which, in the case of brachyuran larvae, is evident in a differential reduction of survival and growth and an increase in duration of zoeal development. (Author's abstract)
W90-03919

ASSESSMENT OF EXPOSURE TO ENVIRONMENTAL MICROCONTAMINANTS AND PESTICIDE RESIDUES IN SCAPHARCA INAEQUIVALVIS.
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
For primary bibliographic entry see Field 5B.
W90-03942

DETECTION OF MUTAGENICITY IN MUSSELS AND THEIR AMBIENT WATER.
Okayama Univ. (Japan). Dept. of Public Health.
For primary bibliographic entry see Field 5A.
W90-03944

SUBLETHAL EFFECTS OF CRUDE OIL ON A COLD-WATER MARINE LEECH, JOHANSSONIA ARCTICA, FOLLOWING CHRONIC EXPOSURE.
Memorial Univ. of Newfoundland, St. John's. Dept. of Biology.
R. A. Khan, and J. W. Kiceniuk.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 590-596, October 1989. 4 fig, 15 ref.

Descriptors: *Oligochaetes, *Oil pollution, *Water pollution effects, *Toxicity, *Benthic fauna, *Sublethal effects, Hydrocarbons, Mortality, Fertility, Population exposure, Canada, Leeches.

The mortality and/or morbidity from the toxic effects of petroleum polyaromatic hydrocarbons (PAH) were studied in the benthic marine leech, Johanssonia arctica, a species indigenous to the continental shelf off eastern Canada. Evidence is provided suggesting that crude oil fractions not only alter egg production in this species, but also the hatching of eggs and survival of progeny. The effect of fractions on cocoon production and emergence of young was investigated in two separate experiments. In the first trial, a greater number of cocoons was deposited by both the control group and the group that had fed on oil-treated cod than by those exposed directly to oil fractions. In the second trial, which involved exposure of two groups to different oil concentrations, oil-treated leeches deposited fewer cocoons than controls, especially at the higher (ca. 150 micrograms/L) concentration. A higher mean number of young emerged from the control (10.7) than from the oil-treated groups exposed to the higher (1.2) or lower (2.5) oil concentrations. A third trial ascertained the effect of duration of exposure to water soluble fractions of a crude oil on reproductive capacity. Fewer cocoons were deposited by the oil-treated leech groups after exposure for 9, 15, 26, 38, 53, and 67 days than by the corresponding controls. This study confirms that chronic exposure of adult J. arctica to water-accommodated fractions of crude oil affects reproduction. (Friedmann-PTT)
W90-03945

IN VIVO MODIFICATION OF LIPID METABOLISM IN RESPONSE TO PHOSPHAMIDON, METHYLPARATHION AND LINDANE EXPOSURE IN THE PENAEID PRAWN, METAPENAEUS MONOCEROS.
Sri Venkateswara Univ., Kavali (India). Div. of Toxicology.
M. Srinivasulu Reddy, and K. V. Ramana Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 603-610, October 1989. 1 fig, 2 tab, 23 ref.

Descriptors: *Water pollution effects, *Pesticides, *Sublethal effects, *Mollusks, *Organic pesticides, Animal physiology, Tissue analysis, Shrimp, Lipids, Aquatic populations, Bioindicators.

The impact of an organophosphorus-phosphamidon and methylparathion and an organochlorine-lindane on the lipids and lipid-derivatives in selected tissues of the penaeid prawn, Metapenaeus monoceros, was determined. This prawn is considered to be a sensitive indicator of marine and estuarine pollution, and also forms one of the commercially important fisheries of India. Laboratory prawns were exposed to sublethal concentrations of phosphamidon (0.4 ppm), methylparathion (0.04 ppm), and lindane (0.0015 ppm) for 72 h. Tissues from the midgut gland, muscle and gill were isolated from control and exposed prawns. Lipids were isolated by repeat extraction. Lipase activity, glycerol, and protein content were determined. In all the three control tissues, the levels of total lipids remained higher in midgut gland compared to muscle and gill tissues. There was a general decrease in the total lipids and glycerol levels in prawns exposed to phosphamidon, methylparathion and lindane, while the free fatty acids and total cholesterol showed a significant increase in all the exposed prawn tissues. This suggests the mobilization of energy-rich lipids for production of energy during toxic stress caused by pesticides. The mobilization of lipid reserves indicated a high energy demand under pesticide toxicity. (Friedmann-PTT)
W90-03946

LABORATORY INDUCTION OF INTERSEXUALITY IN THE MOSQUITOFISH, GAMBUSIA AFFINIS, USING PAPER MILL EFFLUENT.
University of West Florida, Pensacola. Dept. of Biology.
D. T. Drysdale, and S. A. Bortone.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 611-617, October 1989. 1 fig, 18 ref.

Descriptors: *Sublethal effects, *Water pollution effects, *Fish physiology, *Pulp wastes, *Mutagenicity, Fish populations, Population exposure, Androgen, Growth.

To test the hypothesis that masculinization of the mosquitofish, Gambusia affinis, is induced by the kraft mill effluent (KME)-borne androgen or androgen-like substance, newly hatched laboratory reared offspring were experimentally exposed to KME-receiving stream water. Development of secondary sex characters was recorded and compared between KME-exposed fish and non-exposed fish. The mean anal fin length (AFL) of male, non-KME exposed fish increased from 1.29 mm at 8 d of age to 3.34 mm at 88 d of age. Between 88 and 100 d of age, the mean AFL increased to 5.22 mm. Following this increase, the mean AFL among male controls remained between 4.50 and 5.25 mm and did not fluctuate significantly. The AFL of KME-exposed males increased from 1.3 mm at 8 d of age to 3.17 mm at 63 d. Subsequent to 65 and 67 d, the mean AFL in KME-exposed males increased dramatically to 4.74 mm. After 88-100 d, the AFL had increased to 5.00 mm among the KME-exposed males and remained at approximately 5 mm for the duration of the experiment. Differences in AFL length between KME-exposed and non-exposed fish were evident. The relatively early AFL growth rates in the exposed fish could indicate that the presumed androgenic component of KME was exerting its effect on gonopodial development in conjunction with naturally synthesized, endongenous testosterone. (Friedmann-PTT)
W90-03947

EFFECT OF THE EFFLUENT FROM A CHLOR-ALKALI FACTORY ON A BLUE-GREEN ALGA: CHANGES IN THE PIGMENT CONTENT.
Berhampur Univ. (India). Lab. of Environmental Toxicology.
B. P. Shaw, A. Sahu, and A. K. Panigrahi.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 618-626, October 1989. 5 fig, 1 tab, 23 ref.

Descriptors: *Water pollution effects, *Algae, *Industrial wastewater, *Cyanophyta, Suspended load, Hardness, India, Chlor-alkali industry, Chemical analysis, Chlorophyll.

The effect of the effluent from a chlor-alkali factory at Ganjam, India, on the pigment composition of a blue-green alga, Westiellopsis prolifica Janet, was investigated. Analysis of the effluent revealed that it contained 0.465 mg/L Hg, had a pH of 10.5, 19.3 mg/100 ml suspended solids, 90 mg/100 ml dissolved solids, BOD of 39.32 mg/L, COD of 301.38 mg/L, chlorinity of 2,000 mg Cl/L, hardness of 500 mg/L as CaCO3, nitrate nitrogen 1.24 mg/L as NO3(2-), phosphate phosphorus of 0.308 mg/L as PO4(3-), and reactive silicate of 15.4 mg/L as Si. The level of chlorophyll in the exposed alga decreased progressively with increase in concentration of the clear supernatant. In 10% and 20% concentration of supernatant, on the 3 day, the chlorophyll content of the alga decreased to 40% and 38%, respectively over the control. Later, the chlorophyll level increased, but on longer exposure the level again decreased. In 30% treatment, the level of chlorophyll continued to decline until the 9th day (78% over the control), and then increased slightly, due probably to some type of resistance to stress. The effluent, in contrast, showed a marked increase in the level of chlorophyll, particularly 10% concentration. Although 20 and 30% concentrations were also greatly stimulative, the level of chlorophyll in those concentrations decreased slightly over the control on the 15th day of exposure. It was concluded that the effluent was not fit to be discharged as such because: (1) the level of mercury far exceeds the stipulated limit of 0.01 mg/L set by the Central Board for the Prevention and Control of Water Pollution, India; and (2) the supernatant is highly toxic in nature. A rigorous treatment of the effluent is recommended. (Friedmann-PTT)
W90-03948

ANEMIA IN THE FRESHWATER TELEOST, HETEROPNEUSTES FOSSILIS, UNDER THE STRESS OF ENVIRONMENTAL POLLUTION.
Gorakhpur Univ. (India). Dept. of Zoology.
A. S. Narain, and P. N. Srivastava.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 627-634, October 1989. 4 tab, 11 ref.

Descriptors: *Water pollution effects, *India, *Toxicity, *Fish populations, *Fish physiology, Biochemistry, Wastewater, Insecticides, Stress, Chemical analysis, Domestic wastes, Farm wastes.

The toxicity of the water of Ramgarh Lake, India, due to organic enrichment through sewage and contamination by agrochemicals, has reduced the fishery catch of the lake to less than half during the past few years. The deleterious effects of these pollutants on the number, volume, size, hemoglobin content and sedimentation rate of the erythrocytes of the catfish, Heteropneustes fossilis, which inhabits the lake, was investigated. Fish collected from unpolluted habitats were compared with those exposed to the sewage and its chemical factors, including the fertilizers urea and potash, the chlorinated insecticides BHC and Stardrin 20 Shaw Wallace, and the organophosphorus insecticides Nuvacron 40 Ciba and Dimecron 100 Ciba. Sewage was collected just before its entry into the lake and diluted with 25% tap water. Results showed that reduction of erythrocyte sedimentation rate (ESR) was the predominant effect of sewage. N,SO4 and HCO3 increased ESR at chronic stage. NH3-H, PO4, and Ca had a predominantly lowering effect,. Urea increased ESR at the acute stage and reduced it at the chronic stage. Potash lowered it at both stages. The insecticides increased ESR, Dimecron at the acute and others at the chronic stage. The effect of chlorinated insecticides was better sustained. Reduction of mean corpuscular hemoglobin concentration (MCHC) was the predominant effect of sewage. All the sewage factors, except PO4, usually re-

duced MCHC. The effect of fertilizers appeared early, tended to wear off ultimately, was not very sharply defined, and seemed to mainly increase the MCHC. The chlorinated insecticides were mainly depressive, and the organophosphorus insecticides elevatory, for MCHC. Overall, it was shown that erythrocyte characteristics can provide an effective baseline for evaluating pollution-related damage to fish. (Friedmann-PTT)
W90-03949

POSSIBLE EFFECT OF SEDIMENTARY PHOSPHORUS ON THE ACCUMULATION OF LEAD IN MYTILUS EDULIS.
Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.
B. P. Bourgoin, M. J. Risk, and A. E. Aitken.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 43, No. 4, p 635-640, October 1989. 2 fig, 1 tab, 13 ref.

Descriptors: *Water pollution effects, *Bioaccumulation, *Phosphorus, *Lead, *Mollusks, *Mussels, Biochemistry, Absorption, Sediments, Tissue analysis.

Although it has long been recognized that phosphorus (P) may alter the uptake and retention of lead (Pb) in mammals, its effect on the availability of Pb to aquatic invertebrates has not been adequately studied. The effects of varying levels of sedimentary P on the availability of Pb to the common blue mussel, Mytilus edulis, was investigated. Sediment samples were collected from four stations within the Belledune Harbor, New Brunswick, Canada, an area with an industrial complex that produces phosphorite loadings from spillage. In the laboratory, samples of mussel and mussel shell, collected from three stations on the Harbor, were ground with agate mortar. Pb concentrations in the sediment extracts and in the mussel tissue and shell were analyzed with flameless atomic absorption spectrometry. The P concentration in the sediment extracts was analyzed by inductively coupled plasma-mass spectrometry. Pb concentrations in the mussel tissues and shells collected at two stations were significantly higher than the Pb measured in mussels at the third station. Conversely, the sediments at the third station contained twice the amount of Pb than the sediments at the other three stations. The lower Pb levels in the station three mussels may be explained by a higher amount of bioavailable P at this station as evidenced by the higher amounts of P extracted from the sediment. These results did not allow speculation as to the mechanism of the P-Pb relationship, and warrant further investigations into this relationship in the context of uptake in aquatic organisms. (Friedmann-PTT)
W90-03950

LINKING NONPOINT POLLUTION AND DETERIORATION.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
V. Novotny, and G. Bendoricchio.
Water Environment and Technology, Vol. 1, No. 3, p 400-407, November 1989. 5 fig, 2 tab, 6 ref.

Descriptors: *Nonpoint pollution sources, *Wisconsin, *Italy, *Eutrophication, Milwaukee River, Venice, Dissolved oxygen, Organic matter, Photosynthesis, Water quality control, Nitrogen, Phosphorus, Nutrients.

The role of nonpoint source pollution in deterioration of receiving water quality is discussed, including pollution sources, water quality problems, nutrient problems, and remedial action. Examples discussed are the Milwaukee River (Wisconsin) and Venice (Italy). Primary productivity from nutrient flows during medium and low flows is the link between nonpoint and residual point pollution inputs and water quality degradation. Large masses of organic matter can impose dissolved oxygen (DO) demands on receiving waters. Primary production is generally oxygen deficient; that is, a large part of the oxygen produced through photosynthesis is lost because of oversaturation and transport of algae downstream to less aerated areas. In adverse cases, little of the oxygen produced may be included in the DO balance. Control of nutrients from erosion runoff during high flows may not be effective because primary productivity is most active during low flows, and algae and macrophytes may be flushed out during high flows. In addition, turbidity can limit light penetration and inactivate portions of phosphorus and ammoniacal-nitrogen. Diffuse pollution control strategies may need reevaluating. Practices aimed only at soil conservation may not be effective for many receiving waters. (Rochester-PTT)
W90-03953

DISCHARGE OF BACTERIA RESISTANT TO HEAVY METALS FROM SEWAGE EFFLUENT INTO FRESHWATER.
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 5E.
W90-03964

EUTROPHICATION OF RUNNING WATERS: PART 1. EFFECT OF TEMPERATURE, PHOSPHORUS, SILICATE, CARBON DIOXIDE, AMMONIA, NITRATE AND COMPLEXING AGENTS ON THE GROWTH OF PHYTOPLANKTON (LABORATORY STUDIES) (ZUR EUTROPHIERUNG VON FLIESSGEWASSERN: TIEL 1. EINFLUSS VON TEMPERATUR, PHOSPHOR, SILIKAT, KOHLENSTOFFDIOXID, AMMONIUM, NITRAT, UND KOMPLEXBILDNERN AUF DAS WACHSTUM VON PHYTOPLANKTON (LABORVERSUCHE)).
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
W. Pohlmann, U. Kaul, and W. Kopf.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 5, p 187-195, October 1989. 13 fig, 1 tab, 18 ref. English summary.

Descriptors: *Water pollution effects, *Eutrophication, *Lotic environment, *Temperature effects, *Nutrients, *Phytoplankton, Phosphorus, Silicates, Carbon dioxide, Ammonia, Nitrates, Chemical complexation, Rivers, Chelating agents.

In an attempt to explain the extreme variability of the chlorophyll-a content in the lotic environment, the growth of a natural phytoplankton population was measured in more than 380 laboratory trials. The influence of water temperature, nutrient concentration, and nutrient consumption on the growth rate of major algal groups was determined. The re-release of nutrients by phytoplankton was also investigated. For some algal groups, the effect of the nutrients phosphorus, silicate, nitrate, ammonium, and carbon dioxide on relative growth rates was determined; growth rates were found to be directly related to concentrations of these nutrients. Nutrient uptake was characterized by a wide range for silicates (6.5-24 microg Si/microg chlorophyll a) and by a low nitrogen requirement for diatoms (3.7 to 5.6 microg N/microg chl a), as compared with green algae. Availability of trace elements essential for the algal cells was enhanced by the complexing agents EDTA (ethylenediamine tetraacetic acid) and NTA (nitrilotriacetic acid); this in turn distinctly stimulated the eutrophication process subsequent to the initial loading of the water. The release by algae of previously-incorporated nutrients took place very slowly and was species-specific. Carbon dioxide was produced through bacterial degradation. The numerous results obtained in these laboratory studies still only partly answer the initial question about the highly variable chlorophyll-a content of flowing waters. The answer will be more completely learned from field measurements. (See also W90-04000) (Shidler-PTT)
W90-03999

EUTROPHICATION OF RUNNING WATERS: PART 2. EFFECT OF LIGHT, TURBULENCE, DEPTH, AND PRIMARY POLLUTION OF THE RIVER ON THE GROWTH OF PHYTOPLANKTON (IN SITU MEASUREMENTS) (ZUR EUTROPHIERUNG VON FLIESSGEWASSERN: TIEL 2. EINFLUSS VON LICHT, TURBULENZ, GEWASSERTIEFE UND PRIMARBELASTUNG DES VORFLUTERS AUF DAS WACHSTUM VON PHYTOPLANKTON) (IN SITU-MESSUNGEN).
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
W. Pohlmann.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 5, p 196-202, October 1989. 9 fig, 2 tab, 17 ref. English summary.

Descriptors: *Eutrophication, *Lotic environment, *Turbulent flow, *Light penetration, *Water pollution effects, *Wastewater pollution, *Phytoplankton, Rivers, Hydraulics, Primary productivity, Comparison studies, Zooplankton, Temperature effects, Flow velocity.

The meteorological and hydraulic effects on the growth of phytoplankton were examined by in situ measurements using glass tubes of different lengths, vertically exposed in the water. Pollution was determined according to the increase of biomass, the consumption of nutrients, the oxygen production, and the secondary production. The water temperature, light supply, and primary pollution by wastewater influenced the growth rate in relation to the species of phytoplankton. The vertical dispersion of running waters results in a considerable increase in productivity and removes the light inhibition into the upper water layers. The loss rate of phytoplankton was determined by a comparison with the algal growth of the tubes in relation to the running water. Without grazing of zooplankton, the loss rate may be caused primarily by sedimentation of algae and depends on the algal species, water temperature, and velocity of water flow. (See also W90-03999) (Author's abstract)
W90-04000

NITRATE AND AMMONIUM IN THE RHINE: CONCENTRATIONS, LOADS, TREND OF BEHAVIOR, AND ORIGIN, 1954-1988 (NITRAT UND AMMONIUM IM RHEIN - KONZENTRATIONEN, FRACHTEN, TRENDVERHALTEN UND HERKUNFT 1954-1988).
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-04002

ATP-RELATED SPECIFIC HETEROTROPHIC ACTIVITY IN PETROLEUM CONTAMINATED AND UNCONTAMINATED GROUNDWATERS.
Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering.
B. K. Jensen.
Canadian Journal of Microbiology CJM1AZ, Vol. 35, No. 8, p 814-818, August 1989. 1 fig, 4 tab, 18 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Water pollution effects, *Groundwater pollution, *Aquatic bacteria, *Aromatic compounds, *Adenosine triphosphate, *Biomass, Organic compounds, Biodegradation, Oil pollution.

Bacterial numbers, ATP content, heterotrophic potentials, and thymidine incorporation were determined for petroleum contaminated and uncontaminated groundwaters. ATP measurements and cell counts gave variations of a factor of 7 in values among the sites. The acridine orange direct counting yielded counts 2 to 3 orders of magnitude higher than the plate counts and counts 1 to 2 orders of magnitude higher than counts given by the ATP measurement using a conversion factor of 1 femtogram ATP/cell. Mean maximum reaction rate values for 14C-labeled glucose, acetate, and naphthalene were 0.59, 0.17, and 1.14 micrograms/L/hr, respectively. Naphthalene was only used as substrate in the contaminated samples. Acetate and naphthalene showed fairly good correlations to ATP contents, 0.94 and 0.95, respectively, as well as with tritiated thymidine incorporation rates, r = 0.94. Maximum reaction rate specific activity indices (SAI) based on ATP content showed very little variation for the selected groundwaters compared with SAI values reported earlier for groundwaters. (Author's abstract)
W90-04041

IMPACT OF METHOXYCHLOR TREATMENT OF THE SASKATCHEWAN RIVER SYSTEM ON ARTIFICIAL SUBSTRATE POPULATIONS OF AQUATIC INSECTS.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
L. M. Dosdall, and D. M. Lehmkuhl.
Environmental Pollution ENPOEK, Vol. 60, No. 3-4, p 209-222, 1989. 1 fig, 1 tab, 33 ref.

Descriptors: *Methoxychlor, *Insecticides, *Chlorinated hydrocarbons, *Canada, *Pesticides, *Saskatchewan River, *Water pollution effects, *Insects, Population dynamics, Resistance.

The impact of methoxychlor exposure on aquatic insects inhabiting artificial substrates was monitored at three downstream sites relative to an upstream untreated site of the North Saskatchewan River. Treatment impact was studied for selected species of Simuliidae (Diptera), Perlodidae (Plecoptera), Hydropsychidae (Trichoptera), Baetidae, and Heptageniidae (Ephemeroptera). At sites subjected to methoxychlor exposure which were 21, 38, and 107 km from injection, population changes varied depending on species and distance from the injection point. Although populations of some species were not significantly affected by treatment at any downstream site ($P > 0.05$), others were significantly reduced at one or more of the sites ($P < 0.05$-$P < 0.01$). Nymphs of Stenonema terminatur (Walsh) and Baetis tricaudatus Dodds (Ephemeroptera) apparently recolonized after dislodgement due to methoxychlor exposure. Species are categorized on the basis of their responses to methoxychlor treatment. Different treatment impacts among species may be caused by species differences in habitat preference or sensitivity to the pesticide, or a combination of these. (Author's abstract)
W90-04043

EFFECT OF TWO APPLICATIONS OF ATRAZINE ON THE WATER QUALITY OF FRESHWATER ENCLOSURES.
National Museum of Natural Sciences, Ottawa (Ontario). Botany Div.
P. B. Hamilton, D. R. S. Lean, G. S. Jackson, N. K. Kaushik, and K. R. Solomon.
Environmental Pollution ENPOEK, Vol. 60, No. 3-4, p 291-304, 1989. 4 fig, 1 tab, 31 ref.

Descriptors: *Atrazine, *Water quality, *Path of pollutants, *Water pollution sources, *Nonpoint pollution sources, *Agricultural runoff, *Water pollution effects, *Herbicides, Runoff, Ammonium, Calcium, Dissolved solids, Nitrates, Oxygen, Chlorophyll, Organic carbon, Particulate matter, Photosynthesis.

To simulate runoff from agricultural lands, atrazine was applied to aquatic enclosures (112 cu m) on June 1, 1983 at a concentration of 0.1 mg/L. Thirty-five days later the nominal concentration was increased to 0.155 mg/L. Treated enclosures became clearer with Secchi disc readings of 3.6 m compared to non-treated controls (2.9 m). Less than 5% of the first atrazine addition disappeared during the first 35 days and little effect on biological activity was observed. However, with the second enrichment the rate of loss of atrazine was rapid ($t1/2 = 150$ days), ammonium, calcium, dissolved inorganic carbon and nitrate levels were higher, while oxygen, chlorophyll, dissolved organic carbon and particulate organic carbon concentrations were lower in the treated enclosures. These water quality changes cannot be explained by herbicide-water chemistry interactions alone, thereby suggesting an indirect effect as a consequence of atrazine inhibition on photosynthesis and possibly other microbial processes. (Author's abstract)
W90-04045

INCREASED EUTROPHICATION OF THE NORTHERN ADRIATIC SEA.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
D. Degobbis.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 452-457, September 1989. 4 fig, 2 tab, 38 ref. NSF Grant PN-542.

Descriptors: *Eutrophication, *Adriatic Sea, *Yugoslavia, *Phytoplankton, Detritus, Advection, Chlorophyll a, Oxygen, Aggregates, Coastal waters, Organic matter, Water pollution sources, Salinity.

Very calm and warm weather in late spring and early summer 1988 supported intense non-seasonal phytoplankton blooms in the western part of the northern Adriatic which is under direct influence of Po River discharge. Surface salinity decreased to .016, and concentration of chlorophyll a increased up to 17 milligrams/cu m, with oxygen supersaturation to 2.03. Nanoplankton dominated the blooms (up to 76 billion cells/cu m, but diatoms, particularly Chaetoceros species (up to 17 billion cells/cu m), also occurred in large number. Large organic aggregates were formed in the water column with dimensions (up to 2 m long) and in quantities never previously observed. During late summer and early fall aggregates were distributed over the entire region, and a general contamination of the coasts occurred. Oxygen concentration was dramatically reduced in the bottom layer of the entire region, an event not observed to such a degree since 1977. During that year, in contrast to 1988, large quantities of freshwater spread over the entire northern Adriatic causing extended phytoplankton blooms. In 1988 extremely low horizontal advection (current velocities usually below 20 cm/sec) primarily favored an accumulation and high aggregation of detritus, and greatly reduced oxygen concentration in the bottom layer. (Author's abstract)
W90-04062

EFFECTS OF TRIBUTYLTIN POLLUTION ON THE MUD SNAIL, ILYANASSA OBSOLETA, FROM THE YORK RIVER AND SARAH CREEK, CHESAPEAKE BAY.
Marine Biological Association of the United Kingdom, Plymouth (England).
G. W. Bryan, P. E. Gibbs, R. J. Huggett, L. A. Curtis, and D. S. Bailey.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 458-462, September 1989. 4 fig, 29 ref.

Descriptors: *Pesticides, *Antifoulants, *Organotin compounds, *Snails, *Chesapeake Bay, *Water pollution effects, Marine sediments, Bioindicators.

Mud snails, Ilyanassa obsoleta, were collected along gradients of tributyltin (TBT) pollution in the York River-Sarah Creek region of Chesapeake Bay. Development of imposex (the imposition of male characters on female snails) was assessed. Frequencies of imposex and intensities of penis expression were either zero or very low at 3 sites in the York River where water concentrations of TBT were of the order of 2 nanograms/liter. In the northwest branch of Sarah Creek, with water concentrations of around 20 nanograms/liter, the frequency of imposex was 100% and the intensity of penis expression was high. Tissue concentrations of TBT were similar in both sexes and ranged from less than 20 nanograms/gm dry wt at the 3 York River sites to 620-730 nanograms/gm dry wt at a site in the northwest branch of Sarah Creek. An appreciable degree of imposex is induced in I. obsoleta at a seawater TBT concentration of about 10 nanograms/liter and imposex is probably initiated at about 2 nanograms/liter. No evidence was found for the sterilization of I. obsoleta by imposex, but the percentages of females in the samples declined significantly with increasing frequency of imposex. (Author's abstract)
W90-04063

QUALITY OF COMMUNITY DRINKING WATER AND THE OCCURRENCE OF SPONTANEOUS ABORTION.
Harvard School of Public Health, Boston, MA. Dept. of Epidemiology.
A. Aschengrau, S. Zierler, and A. Cohen.
Archives of Environmental Health AEHLAU, Vol. 44, No. 5, p 283-290, September/October 1989. 3 tab, 23 ref. EPA grant CR812728-01-0.

Descriptors: *Water treatment, *Public health, *Drinking water, *Water pollution effects, Mercury, Arsenic, Potassium, Silica, Hardness, Nitrates, Spontaneous abortion, Health effects, Alkalinity, Sulfates.

To investigate the relationship between community drinking water quality and spontaneous abortion, trace element levels in the drinking water of 286 women having a spontaneous abortion through 27 weeks gestation were compared with water trace element levels for 1,391 women having livebirths. Trace element levels were gathered from routine analyses of public tap water supplies from the communities where the women resided during pregnancy. After adjustment for potential confounders, an increase in the frequency of spontaneous abortion was associated with detectable levels of mercury, high levels of arsenic, potassium, and silica, moderately hard water, and surface water. In contrast, a decrease in the frequency of spontaneous abortion was associated with high levels of alkalinity and sulfate, and any detectable level of nitrate. (Author's abstract)
W90-04071

GLUCOSE-MINERALIZATION POTENTIAL OF EPILITHIC BACTERIA IN DIVERSE UPLAND ACID HEADSTREAMS FOLLOWING A WINTER SPATE.
Hull Univ. (England). Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W90-04073

LAKE ACIDIFICATION IN NORWAY: PRESENT AND PREDICTED FISH STATUS.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 2H.
W90-04080

S.C.E.-TESTING OF PACKAGING MATERIAL EXTRACTS AND MONITORING WELL WATER FROM WASTE DEPOSIT SERIES.
Department of Medical Genetics, Vrije Universiteit Brussel, Laarbeeklaan 103, 1050 Brussel, Belgium.
L. Hens, H. Segers, E. V. Emelen, I. Liebaers, and F. Lox.
Bulletin of the Polish Academy of Sciences: Biological Sciences BAPBAN, Vol. 36, No. 10-12, p 235-242, 1988. 2 fig, 4 tab, 9 ref.

Descriptors: *Genetics, *Mutagenicity, *Food processing industry, *Plastics, Sister chromatid exchange test, Food packaging, Water pollution effects, Waste dumps.

Two complex chemical mixtures in a sister chromatid exchange test on human lymphocytes were conducted. Initially an essay to evaluate the mutagenicity from plastic food packaging material was developed; in a second assay, a water fraction from a monitoring well sampled near a waste deposit site was tested. The extraction procedure for the plastics PVC, polystyrene and polypropylene is based upon the Sorchelet extraction and the operations of dispersing the polymer into an adequate solvent followed by precipitation with methanol, filtration, evaporation to dryness of the filtrate containing the full mix of additives. Bidistilled water simulating most aqueous food solutions, and n-heptane, as a fat simulant were used as solvents. The obtained extracts showed no mutagenic activity in a direct sister chromatid exchange testing procedure. The wastewater sample was treated in an alternate way: it was concentrated by means of a freeze-drying technique followed by methanol extraction. The sister chromatid test showed mutagenicity at a low concentration factor. Sister chromatid exchange scores per metaphase clearly exhibit a dose-response relationship. Chromosome groups were affected unequally. Only B and E group scores correlated with concentrations. Metabolic activation showed negative results. Most probably this is due to the limited exposure period (1 hour) of the cells to the mixture of test substance plus metabolic activator. The results show that the sister chromatid test using human lymphocytes can be used as a valuable and sensitive test system for evaluation of the mutagenicity of complex mixtures. (Author's Abstract)
W90-04085

IMPACT OF ORGANIC CONTAMINATION IN THE ENSENADA DE LOURIZAN (ESCORP PROJECT): I. PHYSICAL ENVIRONMENT AND BENTHIC MACROFAUNA, (IMPACTO DE LA CONTAMINACION ORGANICA EN LA ENSENADA DE LOURIZAN (PROJECTO ESCORP): I. EL MEDIO FISICO Y LA MACROFAUNA BENTONICA).

Santiago Univ., La Coruna (Spain). Dept. of Biologia Animal.
M. Mora, M. Planas, and R. Silva.

Cahiers de Biologie Marine CBIMA5, Vol. 30, No. 2, p 181-199, 1989. 5 fig, 2 tab, 53 ref. English summary.

Descriptors: *Bioindicators, *Water pollution effects, *Spain, *Macroinvertebrates, Hydrobia, Capitella, Scolelepis, Phyllodoce, Goniada, Cerastoderma, Organic pollutants, Benthic fauna, Species diversity.

The Ensenada de Lourizan (NW Spain) is an intertidal bottom area polluted by a pulp mill and chlorine-soda industrial complex. The area nearest to the industrial outflow (azoic area) has a high concentration of organic matter and an heterogenous sediment. Another polluted area surrounds the azoic area which can be subdivided into a zone where only Hydrobia ulvae is present and a zone where some endofaunal species live (Capitella capitata, Scolelepis fuliginosa, Phyllodoce groenlandica, Goniada galacia, and Cerastoderma edule). The central area of the Ensenada is the transition area. It is characterized by a higher species richness, a lower content in organic matter and the absence or reduction of species indicative of pollution. In spite of the abnormalities pointed out in sediment and in macrofauna, the effect of industrial outflows in Lourizan is less important than in subtidal bottoms from other organically enriched areas. (Author's abstract)
W90-04088

LONG-TERM CHANGES IN NUTRIENTS, WEED MATS AND SHOREBIRDS IN AN ESTUARINE SYSTEM.

Aberdeen Univ. (Scotland). Culterty Field Station.
For primary bibliographic entry see Field 2L.
W90-04091

GEOGRAPHIC ANALYSIS OF THE INCIDENCE OF CANCER IN QUEBEC AS A FUNCTION OF THE UTILIZATION OF PESTICIDES IN AGRICULTURE, 1982-1983 (ANALYSE GEOGRAPHIQUE DE L'INCIDENCE DES CANCERS AU QUEBEC EN FONCTION DE L'UTILISATION DES PESTICIDES EN AGRICULTURE, 1982-1983).

Montreal Univ. (Quebec). Dept. of Geography.
D. Godon, J.-P. Thouez, and P. Lajoie.

Canadian Geographer CNGGAR, Vol. 33, No. 3, p 204-217, Fall 1989. 8 fig, 4 tab, 38 ref. English summary.

Descriptors: *Water pollution effects, *Pesticide toxicity, *Canada, *Cancer, *Epidemiology, *Groundwater pollution, *Agricultural chemicals, *Drinking water, Public health, Human diseases, Carcinogens, Well water, Rural areas, Quebec, Health effects.

Researchers in Quebec are becoming increasingly concerned about the extensive use of pesticides in agriculture. Data for 1982-83 concerning the use of these products and the incidence of leukemia and of cancer of the brain and the lymphatic tissues have been tabulated for 34 drainage basins located in southern Quebec. The calculation of the standard morbidity ratio permitted the evaluation of the incidence of cancers in these drainage basins where agricultural pesticides have been used at high levels for more than 15 years. For leukemia, a statistically significant higher standard morbidity ratio (1.69, p greater than or equal to 0.05) was shown to exist among men in the rural farm population in the basin of the Yamaska River. This basin was one of the areas most exposed to agricultural pesticides. The calculation of the relative risks for men at the level of municipalities within the Yamaska River basin showed a statistically significant excess for leukemia in the rural farm areas compared to urban municipalities. There was also a statistically significant excess for men in municipalities that draw their drinking water from wells as compared to those where water is drawn from rivers. However, the role of the sources of drinking water is difficult to isolate because most municipalities that draw their water from wells are also agricultural and rural. The overall results of this exploratory study from the basin of the Yamaska River suggest that there may be a relationship between leukemia and the extensive use of agricultural pesticides in the region of Quebec. (Author's abstract)
W90-04096

EXTENT AND HISTORICAL DEVELOPMENT OF THE DECLINE OF DUTCH SOFT WATERS.

Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
G. H. P. Arts, A. J. de Haan, M. B. Siebum, and G. M. Verheggen.

Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen. Series C: Biological and Medical Sciences KNWCAD, Vol. 92, No. 3, p 281-295, September 25, 1989. 7 fig, 1 tab, 32 ref.

Descriptors: *Land reclamation, *Eutrophication, *Acid rain effects, *Water pollution effects, *Water softening, *The Netherlands, *Macrophytes, Littorella, Lobelia, Aquatic plants, Alkaline water, Acidic water.

In the Netherlands the number of sites characterized by soft-water macrophyte species has considerably decreased during this century. An important part of the overall decline can be attributed to reclamation and acidification. Early this century eutrophication was the main cause of degeneration of soft-water vegetation types. At the same time acidification was already affecting sensitive waters by causing alkalinity loss. It was not until several decades later, however, that the detrimental effects of acidification became evident. Duneslacks are now an important refuge for Littorella uniflora in the Netherlands. Acidification is quantitatively important in the decline of inland isoetid sites. Very soft waters acidified before soft waters did. Acidification and eutrophication of waters have had a more detrimental impact on Lobelia dortmanna than on Littorella uniflora. (Mertz-PTT)
W90-04112

BACTERIOPLANKTON BIOMASS AND PRODUCTION DURING DESTRATIFICATION IN A MONOMICTIC EUTROPHIC BAY OF A TROPICAL LAGOON.

Centre de Recherches Oceanographiques, Abidjan (Ivory Coast).
J.-P. Torreton, D. Guiral, and R. Arfi.

Marine Ecology Progress Series MESEDT, Vol. 57, No. 1, p 53-67, September 15, 1989. 6 fig, 6 tab, 45 ref.

Descriptors: *Water pollution effects, *Eutrophication, *Aquatic productivity, *Biomass, *Bacterial analysis, *Bays, Ivory Coast, Electron transport system, Acridine Orange Direct Counts method, Eutrophic bays, Coastal lagoons, Destratification, Aerobic bacteria, Anaerobic bacteria.

Vertical profiles of bacterial biomass (Acridine Orange Direct Counts method), production of biomass (thymidine method) and total Electron Transport System activity were recorded on 14 dates during the destratification process in the monomictic eutrophic Bietri Bay (Ebrie Lagoon, Ivory coast). Bacterial biomass and production were both very high, indicating the importance of heterotrophic processes in this system. Interpretation of Electron Transport System data suggests that bacteria or bacteria-associated organisms are responsible for most of the oxygen consumed in the water column. Integrated bacterial production of biomass represented 80% of carbon produced by primary producers, thus showing that autotrophic production does not meet heterotrophic requirements of bacteria. Destratification appears to be of less importance than suggested by the physical and chemical characteristics, resulting in a decrease of bacterial biomass and production by a factor of 2 in the epilimnion. In the hypolimnion, the anaerobic community characterized by low specific incorporation rates and high mean cellular volume during stratification is replaced by an aerobic community with higher specific thymidine incorporation rates and lower mean cellular volumes. Interpretation of bacterial production of biomass in these newly oxygenated layers demonstrates that oxygen requirements in the aphotic zone are roughly equivalent to autotrophic production of oxygen in the euphotic zone, thus showing that oxygenation of the entire water column is necessarily transient and explaining the return to anoxic condition before the establishment of a new density stratification. (Author's abstract)
W90-04114

EPISODIC RESPONSE PROJECT RESEARCH PLAN.

FTN Associates, Little Rock, AR.
K. Thornton, J. P. Baker, D. Marmorek, D. Bernard, and M. L. Jones.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-138861. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/059, February 1988. 223p, 34 fig, 22 tab, 15 ref. EPA Contract 68-03-3439.

Descriptors: *Acid rain effects, *Research priorities, *Water pollution effects, Monitoring, Biological studies, Fish, Environmental effects, Acidification, Model studies, Water chemistry.

In some geographic locations, acidic deposition is known to be affecting surface water chemistry on both long-term and short-term time scales. Considerable research in the past decade has greatly improved current understanding of the biological effects of acidification, particularly the relationship between chronic chemical conditions and biological responses. In comparison, relatively little is known about the role that short-term acidification is having on the composition or functioning of aquatic biological communities. Despite this scientific uncertainty, it is generally presumed that short-term acidification ('episodes') can result in significant adverse effects on aquatic resources, particularly fish communities. Recognizing episodes as a potentially important source of uncertainty in index-based estimates of acidic deposition effects on populations of lakes and streams, the EPA has initiated the Episodic Response Project (ERP). From an acidification perspective, the ERP is designed primarily to quantify this component of uncertainty in regional population estimates, and to determine the degree to which acidic episodes adversely affect fish populations. Research efforts will focus on streams, rather than lakes. The ERP activities are planned for two stages: Phase I will consist of intensive field studies and empirical modeling and Phase II will combine extensive surveys with model-based regional estimates of episodic effects on surface waters and fish populations. (Lantz-PTT)
W90-04214

EFFECT OF POLLUTANTS ON BIOTA.

Michigan Dept. of Natural Resources, Lansing.
H. A. Tanner.

IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 105-113.

Descriptors: *Water pollution effects, *Urban hydrology, *Water pollution sources, *Water pollution control, Monitoring, Water quality control, Hazardous wastes, Fate of pollutants, Dissolved oxygen, Nonpoint pollution sources, Phosphorus removal, Nutrients.

Problems were recognized in the 1960's with respect to impairment of water quality in Lake Erie, in shore areas of Lake Michigan and certain slow moving rivers. Phosphorus was identified as the key element. A series of control measures from 1967 to 1977 saw a reduction in ambient phosphorus levels to the present 2 mg/L. Levels of about 1 mg/L phosphorus are expected in the future. How-

ever, the following needs still exist in the area of nutrients: (1) an increased ability to monitor effluents discharged from industries and municipal plants; (2) a more accurate determination of waste sources; (3) swifter abatement actions; and (4) greater consideration of on-land disposal. In addition, risk analysis is needed to determine acceptability of the manufacture of toxics. In some cases, there exists enough ecological data to substantiate water quality standards--the establishment of minimal requirements for maintaining cold water fish. Much of what is known in this area is based on biochemical oxygen demand/dissolved oxygen considerations; the database for toxics is lacking. Research is needed to: identify those substances posing or likely to pose the greatest risk in urbanizing areas; assess the role of both the water column and substrate in pollutant impacts; determine the impact of dissolved oxygen fluctuations with respect to other pollutants in urban stretches; assess the threat of toxics present in either the water column or in sediments of downriver reservoirs and lakes. Pesticides from upstream agricultural areas should be considered also; and the relative importance of point and nonpoint nutrient sources in stimulating over-enrichment needs to be assessed. (See also W90-04338) (Lantz-PTT)
W90-04350

EUTROPHICATION AND LAKE MANAGEMENT.
Maine Univ. at Orono. Land and Water Resources Center.
For primary bibliographic entry see Field 2H.
W90-04352

WATER POLLUTION: PESTICIDES IN AQUATIC ENVIRONMENTS. JANUARY 1970-DECEMBER 1988 (CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-853733. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 65 p.

Descriptors: *Bibliographies, *Pesticides, *Water pollution effects, *Path of pollutants, *Fate of pollutants, *Water pollution sources, Literature review, Groundwater pollution, Organophosphorus pesticides, Organic pesticides, Chlorinated hydrocarbons, Arsenicals, Bioaccumulation, Biodegradation.

This bibliography contains 139 citations concerning the physicochemical and biochemical dynamics of pesticides in aquatic environments. The effects of organophosphorus, organochlorine, and arsenical pesticides on marine, surface, and groundwater ecosystems are discussed. Topics include biological fate and transformation of pesticides in waters, sources of release and transport of pesticides, bioaccumulation and metabolism of pesticides by aquatic organisms, ecological concentration and degradability of pesticides in model ecosystems, marine ecology, and guidelines for pesticide registration and pesticide effluents. (Author's abstract)
W90-04484

ASBESTOS IN DRINKING WATER. JANUARY 1977-MARCH 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-856934. Price codes: N01 in paper copy; N01 microfilm. Supersedes PB88-860366. Prepared in cooperation with Office of Water Research and Technology, Washington, DC. Mar 89. 65p.

Descriptors: *Bibliographies, *Water pollution sources, *Asbestos, *Drinking water, Literature review, Public health, Epidemiology, Pollutant identification.

This bibliography contains 94 citations concerning the occurrence and problems associated with asbestos fiber contaminated drinking water. The role of asbestos cement pipes and factors involved in the release of asbestos fibers are discussed. Distribution data, epidemiology studies, and health effects are considered. Detection and measurement methods are also discussed. Ten are new entries to the previous edition. (Author's abstract)
W90-04501

EUTROPHICATION: WATER QUALITY AND POLLUTION CONTROL. JANUARY 1970-JANUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-856314. Price codes: N01 in paper copy; N01 microfilm. Supersedes PB87-858270. Feb 89. 141p.

Descriptors: *Bibliographies, *Eutrophication, *Water quality, *Water pollution control, Literature review, Monitoring, Economic aspects, Mathematical models.

This bibliography contains 294 citations concerning eutrophic analysis, assessment, effects, control, and surveillance of inland and coastal waters. Eutrophication causes, treatment, predictions, and economics are also discussed. Applications of ecological dynamics and mathematical models for eutrophication control of waters are considered. Eighty-eight of these citations are new entries to the previous edition. (Author's abstract)
W90-04504

SCIENCE, LAW, AND HUDSON RIVER POWER PLANTS: A CASE STUDY IN ENVIRONMENTAL IMPACT ASSESSMENT.
For primary bibliographic entry see Field 6G.
W90-04505

SURVIVAL OF FISHES AFTER IMPINGEMENT ON TRAVELING SCREENS AT HUDSON RIVER POWER PLANTS.
EA Engineering, Science, and Technology, Inc., Middletown, NY.
For primary bibliographic entry see Field 8I.
W90-04517

5D. Waste Treatment Processes

BIOTECHNOLOGY FOR DEGRADATION OF TOXIC CHEMICALS IN HAZARDOUS WASTES.
Noyes Data Corporation, Park Ridge, New Jersey. 1988. 697p. Edited by R.J. Scholze, E.D. Smith, J.T. Bandy, Y.C. Wu, and J.V. Basilico.

Descriptors: *Waste treatment, *Cleanup, *Biological treatment, *Biotechnology, *Biodegradation, *Hazardous wastes, *Wastewater treatment, *Detoxification, Organic compounds, Biological wastewater treatment, Nickel, Heavy metals, Oxidation, Recycling, Conferences.

The state-of-the-art of biotechnology for degradation of toxic chemicals in hazardous wastes is discussed in this book. It is based on a conference held in Arlington, Virginia in June of 1986 to assess the applicability of using biotechnology for the treatment of hazardous/toxic wastewaters. Full-scale application of biotechnology for the treatment of municipal and industrial wastewaters has been practiced for many years. However, whether this technology can be employed for detoxification and destruction of hazardous chemicals in aqueous and solid media is not yet fully understood. Removal of toxic and refractory organics in wastewater, groundwater, and leachate may be more efficient as a result of combining biological treatment with other treatment technologies such as chemical and physical methods. Development of standard techniques for biotoxicity detection and toxicity reduction evaluation is essential and extremely important to both technical determination and decisions on the future policy for hazardous waste management. The papers presented in the book describe current research in biotechnology for degradation of toxic chemicals in hazardous wastes, including: (1) suspended-growth inhibited biological systems; (2) methane fermentation of nickel; (3) treatment using aquatic macrophytes; (4) recycling waste sludge; (5) anaerobic treatment; and (6) nitrate oxidation. (See W90-03563 thru W90-03598) (Lantz-PTT)
W90-03562

BIOLOGICAL TREATMENT OF TOXICS IN WASTEWATER: THE PROBLEMS AND OPPORTUNITIES.
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
D. F. Bishop, and N. A. Jaworski.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 1-24, 3 fig, 7 tab, 33 ref.

Descriptors: *Biological treatment, *Detoxification, *Wastewater treatment, *Biological wastewater treatment, Toxicity, Costs, Economic aspects, Environmental protection, Research priorities, Risk assessment.

The toxicity impact on receiving water ecosystems, bioaccumulative uptake of toxics into the food chain, and effects of toxic discharges in wastewater effluents on the water quality of drinking water are strong factors driving the demand for improved technology for control of toxics. Ongoing EPA research should soon provide the scientific tools to support regulatory action by defining the environmental fate and effects and the health risk of toxics, by identifying the presence of toxics and toxicity in water and wastewater, and by tracing the toxics or toxicity to their sources. Effective toxics risk management through risk reduction, however, will require successful improvement of control technology. The EPA is thus addressing 3 major approaches to improve control technology for managing toxics in wastewater--partitioning (sorption) on solids and biomass, volatilization (air stripping and surface desorption), and biodegradation (aerobic and anaerobic). The costs for satisfactory control of the toxics will drive the EPA and the researchers in control technology to search for increasingly efficient and innovative technology. Systems engineering techniques will evolve to provide the tools for selection of technically effective and least costly combinations of control technology in industrial and municipal wastewater treatment and pretreatment and water treatment to meet the water quality and food chain requirements. (See also W90-03562) (Lantz-PTT)
W90-03563

HAZARDOUS WASTE MANAGEMENT: BIOLOGICAL TREATMENT.
National Solid Wastes Management Association, Washington, DC.
S. W. Pirages.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 25-35.

Descriptors: *Wastewater treatment, *Hazardous wastes, *Waste management, *Biological treatment, Wastewater treatment, Batch treatment, Monitoring, Biotechnology, Standards, Administrative agencies, Policy making, Waste management.

The commercial waste service industry recognizes the potential application of biological treatment for industrial hazardous wastes. Facilities employing this technique currently exist in Canada and the United States. Greater application and commercial development is possible, particularly if certain operational/performance criteria are met. These include: complete destruction of hazardous constituents; the ability to concentrate target constituents for further treatment or for resource recovery; application of the technology to a diverse range of hazardous constituents found in mixtures, rather than in single constituent waste streams; and, consistency among treatment batches to reduce the need for expensive monitoring of the residue, and

of the ability to be competitive financially with other treatment technologies that are currently available. Advocates of biological technology should be concerned about and watchful of the developing Environmental Protection Agency policy on Resource Conservation and Recovery Act treatment standards. Depending on the direction of this policy, commercial development of biological treatment technology could be affected adversely. It will be necessary for experts in this area to work with the Agency in identifying the needed data and in validating 'real world' applications of these data. If the Congressional mandate to treat all hazardous wastes includes the broadest possible range of management options, it will be to the benefit of all. However, a concerted effort is required to assure that policies, which optimize treatment opportunities, leave the door open for new research and development. (See also W90-03562) (Lantz-PTT)
W90-03564

COMPETITIVE KINETIC MODEL OF SUSPENDED-GROWTH INHIBITED BIOLOGICAL SYSTEMS.
Pontificia Univ. Catolica de Chile, Santiago. Dept. of Hydraulic Engineering.
P. B. Saez.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 67-81, 9 fig, 17 ref. National Commission of Scientific and Technological Research Grant 0126/85.

Descriptors: *Inhibition, *Kinetics, *Biological wastewater treatment, *Wastewater treatment, *Model studies, Mass balance, Mathematical models, Mathematical equations, Biological treatment, Research priorities, Wastewater reactors.

A kinetic model of suspended-growth inhibited biological systems is presented. The main contribution of the model is that it helps in the identification of research needs in kinetic modeling of inhibited systems. First, it is clear that more experimental results are required. Second, the model has been structured to visualize its assumptions, which can be changed in order to find those that better represent the real world. For example, it is possible to construct models in which the inhibitor utilization rate follow an Haldane function, or the substrate utilization rate can be modeled by uncompetitive or noncompetitive reversible inhibition, or the active bacterial growth also depend on the inhibitor utilization rate. The model may be easily applied to batch or plug-flow suspended-growth reactors. The only changes are related to mass balance equations. Also, its principles could be used to model inhibited biofilm reactors. (See also W90-03562) (Lantz-PTT)
W90-03566

TOXICITY OF NICKEL IN METHANE FERMENTATION SYSTEMS: FATE AND EFFECT ON PROCESS KINETICS.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
S. K. Bhattacharya, and G. F. Parkin.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 82-101, 7 fig, 7 tab, 21 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Nickel, *Toxicity, *Methane, *Fermentation, *Kinetics, Bacterial analysis, Solids retention time, Model studies, Anaerobic digestion, Literature review, Acclimatization, Slug tests, Continuous tests, Methanogenesis, Inhibition, Industrial wastewater, Tolerance, Domestic wastes, Sludge, Hydrogen ion concentration, Acetates, Propionates, Sludge solids, Microbial degradation.

The applicability of anaerobic processes for treatment of industrial wastewaters and domestic sludges has been recognized for many years. The toxicity of heavy metals depends upon the various chemical forms which the metal may assume under anaerobic conditions and at near neutral pH. From a review of the literature it appears that very little research has focused on kinetics of anaerobic systems exposed to nickel, or on the fate of nickel during anaerobic treatment. Little work has been done to quantify the effect of solids retention time (SRT). The objectives of the research were to study the kinetic effects of nickel on anaerobic utilization of acetate and propionate and to determine its fate in these systems. Nickel was added both as slug and continuous doses. With the shock of a slug addition, there should be minimal chance for acclimation to nickel by the bacteria. With continuous addition, however, the concentration of nickel can be increased gradually and the bacteria will have a chance to acclimate. The following conclusions are drawn from this study: (1) Acetate-utilizing methanogens are more severely affected than propionate utilizers by nickel. (2) Massive slug doses of nickel immediately stop bacterial activity--smaller slug doses give lower hydraulic retention time systems a better chance to recovery. (3) Response to nickel toxicity is similar to uncompetitive inhibition; the incompetitive-inhibition-coefficient model worked well for continuous addition of nickel. Best-fit inhibition coefficient (K sub I) values varied between 80 and 150 mg/L depending on SRT; the observed increase in K sub I with increasing SRT indicates acclimation; (4) the uncompetitive-inhibition-coefficient model did not adequately describe the fate of systems exposed to slug doses of nickel. (5) Without acclimation to nickel, total soluble nickel concentrations above 6 mg/L caused failure; total soluble nickel concentrations as high as 31 mg/L could be tolerated with acclimation. (See also W90-03562) (Lantz-PTT)
W90-03567

HEAVY METAL REMOVAL BY AQUATIC MACROPHYTES IN A TEMPERATE CLIMATE AQUATIC TREATMENT SYSTEM.
New Hampshire Univ., Durham. Dept. of Civil Engineering.
P. L. Bishop, and J. DeWaters.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 102-119, 5 tab, 11 ref. NSF Grant CEE-8209851.

Descriptors: *Temperate zone, *Macrophytes, *Aquatic plants, *Wastewater treatment, *Biological wastewater treatment, *Heavy metals, Elodea, Copper, Lead, Zinc, Nickel, Cadmium, Biological treatment, Biological magnification, Epiphytes, Secondary wastewater treatment, Tertiary wastewater treatment.

Research was begun in 1982 to examine and assess the feasibility of using aquatic macrophytes and their associated bacteria in temperate regions as a combined secondary and tertiary wastewater treatment process. A number of temperate region submersed aquatic macrophytes were evaluated for potential use in these systems. Those showing promise were used in pilot-scale treatment units and tested over a two year period. The results indicate that an Elodea-based aquatic treatment system can operate on a seasonal basis at loading rates and hydraulic detention times similar to hyacinth-based systems while providing good secondary and tertiary treatment of domestic primary effluent and maintaining good plant productivity. One phase of this research effort concerned the removal of heavy metals from the wastewater by the aquatic macrophytes. This paper discusses that phase of the research. These studies suggest that the heavy metal removal efficiencies of various aquatic macrophyte treatment systems varies depending on the metal considered, but that the underlying removal mechanisms are probably the same. In essentially all cases, metal removals in the macrophyte-containing reactors were better than in the control reactors. Much of this additional removal is probably due to the epifloral biofilms growing on the macrophytes rather than to the macrophytes themselves. This is potentially very beneficial to the plants as it prevents high concentrations of toxic heavy metals from bioconcentrating in the macrophyte's tissues. Copper was almost entirely removed from the waste streams in aquatic treatment systems containing the temperate climate macrophytes Elodea nuttallii and Myriophyllum heterophyllum; substantial quantities of lead and zinc were also removed. Removal rates for cadmium and nickel were much lower, but this may have been due to the low concentrations present in the raw wastewater. (See also W90-03562) (Lantz-PTT)
W90-03568

REMOVAL OF HEAVY METAL BY RECYCLING OF WASTE SLUDGE IN THE ACTIVATED SLUDGE PROCESS.
Feng Chia Univ., Taichung (Taiwan). Dept. of Hydraulic Engineering.
K. L. Tsai, and P. S. Cheung.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 120-136, 6 fig, 6 tab, 4 ref. Republic of China National Science Council Project NSC 75-0410-E035-01.

Descriptors: *Sludge utilization, *Wastewater treatment, *Recycling, *Activated sludge process, *Heavy metals, Sludge, Biological wastewater treatment, Adsorption, Chemical oxygen demand, Aeration, Biological treatment, Sedimentation.

In the conventional activated sludge process, part of the settled sludge from the final clarifier is returned to the aeration tank; the rest of the sludge is wasted. It has been known for a long time that activated sludge has a very strong adsorption power. In this study, the wasted sludge is recycled to the incoming sewage so that it can adsorb the heavy metals and part of the organic matter. This sludge is then removed to the primary settling tank, simultaneously protecting the biological unit from excess incoming toxic heavy metal ions and reducing the organic load to the aeration tank. This saves a considerable amount of energy. In this study, a jar test was used to investigate the feasibility of this application. Results indicate that the activated sludge did in fact have a very high adsorption capacity. Compared to plain sedimentation with added activated sludge, additional chemical oxygen demand removal ranged from 11-25% and heavy metal varied from 15-32%. (See also W90-03562) (Author's abstract)
W90-03569

EFFECT OF INORGANIC CATIONS ON BIOLOGICAL FIXED-FILM SYSTEMS.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
R. W. Peters.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 137-158, 2 fig, 2 tab, 46 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Cations, *Biofilm reactors, *Heavy metals, Inorganic compounds, Trickling filters, Anaerobic filters, Microbial degradation, Sorption, Fixed film processes, Biofiltration.

The effects and inhibitions associated with heavy metals (Ag, Cr, Cu, Pb, and Zn) on the performance of fixed film biological processes such as trickling filters, anaerobic filters, and rotating biological contactors, are addressed. High concentrations of heavy metals are toxic to most microorganisms. With proper acclimation, the biological system can be used to remove a certain amount of the metal(s) without being adversely affected. The removal of cations, particularly heavy metals, is primarily due to sorption of both soluble and fine particulate by the biofilm. The anaerobic filter is quite efficient for removal of heavy metals and retention of the metals in the biofilm. Due to the relatively recent development of fixed film processes, much less attention has been paid on these processes (as compared to suspended growth systems) particularly in terms of heavy metal inhibition. (See also W90-03562) (Lantz-PTT)
W90-03570

PHYSICAL-CHEMICAL AND ANAEROBIC FIXED FILM TREATMENT OF LANDFILL LEACHATE.
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.

D. Thirumurthi, S. M. Rana, and T. P. Austin.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 159-195, 13 fig, 13 tab, 16 ref.

Descriptors: *Biofilms, *Waste disposal, *Water pollution prevention, *Wastewater treatment, *Physicochemical treatment, *Landfills, *Leachates, *Anaerobic digestion, Hydrogen ion concentration, Heavy metals, Alum, Flocculation, Fixed film processes, Chemical oxygen demand, Suspended solids, Volatile solids, Biofilm reactors, Canada.

A Regional (solid waste) Landfill site which receives approximately 600 metric tons of municipal refuse per working day from the cities of Halifax, Dartmouth, and Bedford and the County of Halifax, Nova Scotia, Canada, covers about 145 hectares (ha) of land area, of which approximately 30 ha has been cleared by 1982. Leachate is collected by means of a system of 150 mm diameter perforated poly-vinyl chloride (PVC) collectors which underlie the filled area. These collectors ultimately drain into two anaerobic lagoons (which can be operated either in series or in parallel) followed by four holding ponds (which are operated in series). The single most important factor that governs the precipitation of metals such as Al, Cr, Fe, Mn, Ni, V and Zn from the leachate is pH. Although alum at 80 mg/L and FeCl3 at 200 mg/L enhanced the precipitation of the metals, the expected higher costs associated with the chemicals and the disposal of excess sludge produced prohibit the use of the chemicals. Sodium carbonate, even at a high dose of 4000 mg/L, was not effective in removing the metals. Subsequent to physical-chemical treatment and phosphate supplementation, the leachate was successfully treated biologically. The upflow anaerobic fixed film reactor (AFFR) with modular blocks, at an organic load of 1.6 kg/day/cu m and at about 32 C, reduced the chemical oxygen demand of the pre-treated leachate from 21,800 to 780 mg/L, total organic carbon from 7680 to 200 mg/L, volatile suspended solids (VSS) from 237 to 24 mg/L and suspended solids from 756 to 36 mg/L. When the biomass within the reactor was estimated on the last day of the experiment, it was concluded that 77% of the biomass (VSS) was in the liquid phase of the reactor held in the interspaces of the medium while the balance was on the biofilm of the solid medium. The substrate removal rate was estimated to be 1.77 g of COD/day per gram of VSS in the liquid phase of the reactor. (See also W90-03562) (Lantz-PTT)
W90-03571

TREATMENT OF LEACHATE FROM A HAZARDOUS WASTE LANDFILL SITE USING A TWO-STAGE ANAEROBIC FILTER.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-03572

EFFECTS OF EXTENDED IDLE PERIODS ON HAZARDOUS WASTE BIOTREATMENT.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-03573

TECHNIQUE TO DETERMINE INHIBITION IN THE ACTIVATED SLUDGE PROCESS USING A FED-BATCH REACTOR.
Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
A. T. Watkin, and W. W. Eckenfelder.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 244-259, 4 fig, 3 tab, 10 ref.

Descriptors: *Inhibition, *Wastewater reactors, *Wastewater treatment, *Activated sludge process, Dichlorophenol, Glucose, Biological wastewater treatment, Statistical studies, Sludge digestion, Biological treatment, Chlorinated hydrocarbons, Model studies, Slug tests, Enzymes, Population dynamics.

While many toxic organic compounds have been successfully treated in laboratory activated sludge units receiving steady-state inputs, difficulty arises in plants when unsteady-state or slug inputs occur. Modeling of an activated sludge systems' response to unsteady state inputs of a known inhibitory compound is the primary focus of this paper. The fed-batch reactor technique is believed to provide an excellent method to rapidly determine unsteady-state inhibition effects of toxic organics in activated sludge. The test is quite precise and requires a minimum amount of time. Distinctly different inhibition constants were obtained for three sludges with different histories. These differences were shown to be statistically significant by Tukey's Method at a global significance level of 5%. A sludge acclimated to 2,4-dichlorophenol (DCP) and glucose demonstrated a mean inhibition constant (K sub I) value of 17.4 mg/L. This value was significantly higher than for sludge which was previously but not currently acclimated to DCP, demonstrating an inhibition constant of 6.5 mg/L. A third sludge which like the others was acclimated to glucose, but which had never been acclimated to DCP, demonstrated the highest mean K sub I value of 40.4 mg/L. From these results it is apparent that there is no universal inhibition constant for DCP on glucose removal. The inhibition constant for DCP appears to be highly dependent on the specific enzyme system involved, which in turn is dependent on the history and population dynamics of the sludge. (See also W90-03562) (Lantz-PTT)
W90-03574

COMPARISON OF THE MICROBIAL RESPONSE OF MIXED LIQUORS FROM DIFFERENT TREATMENT PLANTS TO INDUSTRIAL ORGANIC CHEMICALS.
New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering.
G. Lewandowski, D. Adamowitz, P. Boyle, L. Gneiding, and K. Kim.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 260-274, 7 fig, 3 tab, 3 ref. NSF Project BICM-6.

Descriptors: *Biological wastewater treatment, *Microbiological studies, *Wastewater facilities, *Biological treatment, *Microbial degradation, *Mixed liquors, *Industrial wastewater, *Wastewater treatment, *Organic compounds, Municipal wastewater, Phenols, Chlorophenol, Dichlorophenol, Dichlorophenoxyacetic acid, Biological wastewater treatment, Comparison studies.

As the first stage of an effort to determine the ability of publicly owned treatment works (POTWs) to detoxify industrial organic chemicals, several compounds were added individually to the mixed liquors from two very different treatment plants--the Livingston (NJ) municipal wastewater treatment plant, and the Passaic Valley Sewerage Commissioners (PVSC) plant in Newark, NJ. The former handles 2.5 million gallons/day (mgd) of domestic sewage, while the latter handles 250 mgd of wastewater with a 55% industrial component (on a biochemical oxygen demand (BOD) basis). An aerated batch reactor was used, and the chemicals (and feed concentrations) were: phenol (100 parts per million (ppm)), 2-chlorophenol (20 ppm), 2,6-dichlororphenol (10 ppm), and 2,4-dichlorrophenoxyacetic acid (10 ppm). Substrate disappearance was determined by gas chromatography, and the microbial systems characterized by microscopy and plating techniques. Although the two mixed liquors came from very different systems, their response to the industrial chemicals added, as well as the initial and final microbial populations, were very similar. This suggests that the phenomena observed might be generalized to many other POTWs. (See also W90-03562) (Lantz-PTT)
W90-03575

SBR TREATMENT OF HAZARDOUS WASTEWATER: FULL-SCALE RESULTS.
K. L. Norcross, R. L. Irvine, and P. A. Herzbrun.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 275-291, 7 fig, 3 tab, 10 ref.

Descriptors: *Wastewater reactors, *Wastewater facilities, *Pretreatment of wastewater, *Wastewater treatment, *Hazardous wastes, *Biological wastewater treatment, Sequencing batch reactor, Batch treatment, Aeration, Temperature, Heavy metals, Phenols, Organic compounds, Costs, Biological treatment, Cost analysis, Oxygen transfer, Energy, Toxicity, Suspended solids.

A preliminary pilot study was completed to evaluate the possibility of utilizing the sequencing batch biological reactor (SBR) process to pretreat landfill leachate and hazardous waste streams prior to polishing with the existing activated carbon system. The motivation for the study was a desire to reduce carbon regeneration energy and make-up costs. The results of the pilot study were successful and a full-scale, 550,000 gallon SBR was designed and installed in the winter of 1983/84 in Niagara Falls, New York. Qualitative parameters associated with oxygen transfer (alpha, beta) were evaluated during the pilot study. The data indicated that alpha increased with increasing aeration turbulence and shear rate. Process performance was shown to be highly temperature sensitive, decreasing rapidly at low temperatures. A submerged jet aeration system was selected for high efficiency, high heat conservation, independent aeration and mixing, and alpha resistance. After one year of operation, the plant has proven to be stable and effective. The system maintained a mixed liquor temperature 10 C above the influent temperature. Oxygen transfer alpha values were measured to range between 0.75 and 2.0, while beta values ranged from 0.6 to 0.75 (TDS was 30,000 mg/L). The system operated at roughly half the design power requirements. The system maintained stability throughout the entire year except for two heavy metal toxicity strikes which decreased treatment efficiency for several days. The effluent decanting system and rapid settleability of the mixed liquor resulted in minimum effluent suspended solids values. As a result of the organic and phenol removal efficiencies achieved by the SBR, carbon changes were reduced by about 50%. Annual carbon cost savings are estimated to be $200,000/yr. (See also W90-03562) (Author's abstract)
W90-03576

USE OF PURE CULTURES AS A MEANS OF UNDERSTANDING THE PERFORMANCE OF MIXED CULTURES IN BIODEGRADATION OF PHENOLICS.
New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering.
G. Lewandowski, B. Baltzis, and C. P. Varuntanya.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 292-315, 17 fig, 10 ref.

Descriptors: *Microbial degradation, *Biodegradation, *Phenols, *Wastewater treatment, *Culturing techniques, Biological wastewater treatment, Bacteria, Serratia, Klebsiella, Pseudomonas, Microbiological studies, Model studies, Biomass, Performance evaluation.

Eleven dominant bacterial species were isolated from a phenol-acclimated mixed liquor obtained originally from the Passaic Valley Sewerage Commissioners wastewater treatment plant in Newark, NJ. However, of these eleven species, only three (Klebsiella pneumoniae, Serratia liquefaciens, and Pseudomonas putida) were able to degrade phenol. Therefore, the remaining eight species must have survived by utilizing the metabolic products of the three primary phenol degraders. Regarding the three primary phenol degraders, when the same species were purchased from commercial suppliers, they could not degrade phenol, which underlines the importance of the strain as well as the species. Using the kinetic parameters from the single species experiments, a simple competitive model was tested for phenol utilization by any two of the three primary phenol degraders. This model was able to predict the rate of total biomass growth fairly well, but was much less accurate in predicting the rate of substrate utilization. This indicates that simple competition for the same substrate is

not an adequate physical model for the mixed culture system. It may be, for example, that one (or both) of the organisms is producing an inhibitory agent for the growth of the competing organism. (See also W90-03562) (Lantz-PTT)
W90-03577

COMPARTMENTALIZED ONE SLUDGE BIOREACTOR FOR SIMULTANEOUS REMOVAL OF PHENOL, THIOCYANATE, AND AMMONIA.
Florida International Univ., Miami. Dept. of Civil and Environmental Engineering.
J. H. Greenfield, and R. D. Neufeld.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 316-328, 1 fig, 1 tab, 12 ref.

Descriptors: *Activated sludge process, *Wastewater reactors, *Wastewater treatment, *Phenols, *Thiocyanates, *Ammonia, Biological wastewater treatment, Sludge treatment, Sludge digestion, Biological treatment, Physicochemical treatment, Advanced wastewater treatment, Bulking sludge, Waste removal efficiency, Settleable solids, Industrial wastewater, Aeration.

There are many 'advanced wastewater' treatment processes based on physical-chemical and biological techniques for the removal of ammonia, however. These processes are not often employed in industry due to economics, marginal over-all removal efficiencies and questionable technological application to specific industrial operations. Of the processes available for the removal of ammonia from steel industry wastewaters, engineered biological systems are the most pragmatic. The one compartment bioreactor displays 99% removal efficiencies for phenol, thiocyanate, and ammonia when the influent concentrations for all three substrates was approximately 150 mg/L and when the reactor was operated at an actual sludge age of 43 days. When the influent substrate concentrations were raised to values > 200 mg/L/day, both ammonia and thiocyanate breakthrough were experienced coupled with bulking conditions. The two compartment bioreactor displays > 99% removal efficiencies for thiocyanate, phenol, and ammonia when the reactor consisted of SCN(-) = 350 mg/L, phenol = 300 mg/L, and NH3 = 200 mg/L at an actual sludge age of 42 days. The biota in this reactor demonstrated excellent settleability characteristics. Experimental results from the three and four compartment reactors at sludge ages of 63 and 57 days respectively, exhibited similar effluent phenol and ammonia concentrations. Bulking was experienced with the three and four compartment configurations possibly due to the lack of sufficient substrates in the latter compartments. The steady-state results from the 1-4 compartment reactors displayed > 90% removal of all three substrates in the first compartment with the remaining compartments functioning as final polishing tanks. By utilizing compartmentalized reactors, the working volume of the aeration basin can be reduced by as much as one half without a loss in efficiency. (See also W90-03562) (Lantz-PTT)
W90-03578

HIGH-RATE BIOLOGICAL PROCESS FOR TREATMENT OF PHENOLIC WASTES.
Delaware Univ., Newark. Dept. of Civil Engineering.
A. F. Rozich, R. J. Colvin, and A. F. Gaudy.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 329-358, 7 fig, 1 tab, 22 ref, append.

Descriptors: *Biological wastewater treatment, *Phenols, *Wastewater treatment, Microbial degradation, Mathematical studies, Sludge digestion, Sludge treatment, Biodegradation, Wastewater reactors, Process control, Wastewater facilities.

A proposed process flow scheme for a high-rate fluidized biological system for treating phenol wastes is presented. The key feature of this system is the use of two reactors each of which has different operating conditions. The first stage of the system is utilized for selective culture of organisms which are characterized by high-rate phenol degradation kinetics; the critical parameter for selecting these populations appears to be the maintenance of relatively high (> or = 100 mg/L) steady-state phenol concentrations in this reactor. The second stage of the system is operated in an extended aeration mode (extremely low growth rates) in order to achieve low effluent organic concentrations. The advantages of this process over conventional technology are significantly increased phenol degradation rates and lower sludge production rates; the results of the bench-scale pilot study indicate that the process may also be capable of delivering lower phenol concentrations than can a conventional single-stage technology. Equations were also derived which may be utilized, subsequent to additional developmental work on the process, for providing guidelines for design and operation. Provided the appropriate process controls are available, it should be feasible to use the process model to achieve treatment goals and optimize operation. Finally, application of the high-rate process technology is not contingent on the design of new facilities. The application can be made by modifying existing facilities. That is, the process can be applied by insuring that the appropriate level of controls and the two-stage flow scheme are achievable at a particular treatment facility. (See also W90-03562) (Lantz-PTT)
W90-03579

PROCESS DEVELOPMENT AND TREATMENT PLANT STARTUP FOR AN EXPLOSIVES INDUSTRY WASTEWATER.
D. M. Potter.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 387-419, 12 fig, 7 tab, 2 ref.

Descriptors: *Biological wastewater treatment, *Wastewater facilities, *Industrial wastewater, *Wastewater treatment, Biochemical oxygen demand, Chemical oxygen demand, Sludge treatment, Sludge digestion, Toxicity, Fathead minnows, Retention time, New Jersey, Case studies, Bacteria, Detoxification, Lethal limit, Retention time, New Jersey, Aerobic treatment, Anaerobic digestion, Raw wastewater.

This case study covers the process development and treatment plant startup for the Hercules Plant in Kenvil, New Jersey. Two treatment processes were modeled on bench-scale; the first a conventional aerobic activated sludge process, and the second a two-stage anaerobic/aerobic activated sludge process. No matter which process was used, there was a prolonged acclimation period associated with this wastewater. The raw wastewater was acutely toxic to fathead minnows at very low concentrations because it takes a substantial period of time to develop bacteria which are able to degrade this wastewater. Also notable with both processes was the high sludge retention time (SRT) that developed from successful bench-scale conditions. In the case of the strictly aerobic process, the SRT was 21 days. For the combined two-stage anaerobic aerobic process, the SRT was 160 days. This long SRT is indicative of the recalcitrant nature of the organics in this wastewater. Once bacteria which are capable of degrading these organics are developed, the bacteria must be maintained in the system for a long period of time in order to successfully treat the wastewater. Also characteristic of both systems investigated was complete toxicity removal. After treatment, a raw wastewater with an LC sub 50 of 2% by volume is completely nontoxic. Perhaps most important, all of the results demonstrate that with patience and proper process control and acclimation, conventional biological treatment processes are capable of successfully treating acutely toxic wastewaters. The conventional aerobic activated sludge process was chosen for the full-scale start up. As with the bench-scale units, there was a 30-day acclimation period during which there was marginal treatment efficiency. Effluent biochemical oxygen demand (BOD) and chemical oxygen demand (COD) discharges are meeting permit conditions. One 96-hr static renewal acute toxicity test was run using fathead minnows. No measurable toxicity was detected, even in 100% effluent. (See also W90-03562) (Lantz-PTT)
W90-03582

UTILIZATION OF NITRITE OXIDATION INHIBITION TO IMPROVE THE NITROGEN ELIMINATION PROCESS.
Toronto Univ. (Ontario). Dept. of Civil Engineering.
S. Suthersan, and J. J. Ganczarczyk.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 420-442, 6 fig, 1 tab, 22 ref.

Descriptors: *Nitrites, *Oxidation, *Inhibition, *Denitrification, *Wastewater treatment, Biological wastewater treatment, Nitrification, Nitrobacter, Nitrosomonas, Biomass, Ammonia, Biological treatment, Aeration, Activated sludge process, Hydrogen ion concentration.

Under the usual circumstances in biological waste treatment systems, the phenomenon of inhibition is considered as an event deteriorating the performance of the system. But, for the purpose of modifying the nitrification-denitrification process, inhibition could be advantageous. In addition to the inhibitory effects caused by free ammonia (FA), the pH itself plays an additive role in the inhibition of nitrobacter. By continuously and gradually acclimating nitrobacter to increasing FA concentrations, it was found that adaptation to higher concentrations took place. But this adaptation was found to be only temporary and, by deadapting, the Nitrobacter regained its original characteristics. Thus, by intermittently providing inhibitory and recovery environments in the inhibition chamber and aeration tank, respectively, the adaptation of Nitrobacter, to higher FA concentrations could be prevented. Therefore, it is not necessary to increase the required inhibitory FA concentration in the inhibition chamber due to adaptation of the biomass. Higher biomass concentrations were found to be less sensitive to the same inhibitory conditions than were the more diluted mixed liquors. At lower biomass concentrations, recovery time seems to reach a constant value at around 4.5 hours, but with higher biomass concentrations, a significantly higher FA concentration (> 4 mg/L) has to be provided to obtain the same recovery time. During the initial period when brought back to favorable conditions, the activity of nitrosomonas was reduced due to the inhibitory environment provided earlier to suppress Nitrobacter activity. The biomass inhibited at a pH of 8.8, was slower to recover initially than that inhibited at 8.4. Providing an inhibitory environment above the pH value of 8.8 was not possible, because Nitrosomonas lost its activity permanently. A continuous flow modification of the activated sludge process to suppress the second stage of nitrification proved to be possible. (See also W90-03562) (Lantz-PTT)
W90-03583

ANAEROBIC TREATMENT OF MOLASSE SUGAR CANE STILLAGE WITH HIGH MINERALS.
Societe Generale pour les Techniques Nouvelles, Saint-Quentin-en-Yvelines (France).
M. Henry, E. Michelot, and J. P. Jover.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 443-448, 2 tab.

Descriptors: *Biological wastewater treatment, *Food-processing wastes, *Anaerobic digestion, *Wastewater treatment, *Industrial wastewater, *Minerals, Chemical oxygen demand, Biological treatment, Biofilm reactors.

Mesophilic anaerobic digestion of molasse cane stillage containing high level of minerals has been studied with a 25 liter fixed film reactor. At a constant loading rate of 16 kg chemical oxygen demand (COD)/cu m/day, the reactor is fed with diluted molasse cane stillage; this dilution is then progressively reduced, leading to an increase of soluble minerals in reactor from 2.0 to 26.5 g/L

without decreasing of the system performances, in terms of gas productivity and pollution abatement. Hydraulic detention time = 3.8 days; loading rate = 16 kg COD/cu m/day; biogas productivity = 5.8 cu m/cu m/day; and COD removal = 71%. (See also W90-03562) (Lantz-PTT)
W90-03584

POTENTIAL FOR ANAEROBIC TREATMENT OF HIGH SULFUR WASTEWATER IN A UNIQUE UPFLOW-FIXED FILM-SUSPENDED GROWTH REACTOR.
Sydlo, Inc., Mississauga (Ontario).
L. S. Love.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 449-462, 2 fig, 6 ref, append.

Descriptors: *Biofilm reactors, *Anaerobic digestion, *Sulfur, *Wastewater treatment, *Fixed film processes, Biological wastewater treatment, Sulfides, Costs, Biological treatment, Operating costs, Biogas.

The Sydlo anaerobic reactor *Sydlo, Inc., Mississauga, Canada) has been designed specifically to remove large quantities of biogas as it is generated within the reactor. Because of this feature it is ideally suited for the treatment of high sulfur wastewater. The degree of soluble sulfide removal can be controlled by selecting the appropriate supernatant recycle rate. Simple, adjustable weirs are provided, on the gas separators, for this purpose. The advantage of this technology is that it will substantially reduce daily operating costs. Although this reactor is particularly well suited for the treatment of high sulfur wastewaters, it may also be used, with considerable advantage, when treating other wastewaters where sulfide toxicity is not a problem. (See also W90-03562) (Lantz-PTT)
W90-03585

ANAEROBIC DIGESTION OF CHEMICAL INDUSTRY WASTEWATERS CONTAINING TOXIC COMPOUNDS BY DOWNFLOW FIXED FILM TECHNOLOGY.
Societe Generale pour les Techniques Nouvelles, Saint-Quentin-en-Yvelines (France).
M. Henry, Y. Thelier, and J. P. Jover.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 463-4771, 2 fig, 4 tab, 3 ref.

Descriptors: *Biofilm reactors, *Anaerobic digestion, *Chemical wastewater, *Fixed film processes, *Wastewater treatment, Industrial wastewater, Biological wastewater treatment, Chemical oxygen demand, Biomass, Toxicity.

Treatment of high-strength acidic wastewater containing cyclic acetals in a 20 cu m industrial-scale downflow mesophilic, anaerobic fixed film process occurred without any problem after reaching a loading rate of 11 kg chemical oxygen demand (COD)/cu m/day within 7 months. This anaerobic fixed film process can be utilized for digestion of high strength acidic wastewater containing up to 1.3 kg/cu m of cyclic acetals after biomass accumulation. Utilizing this process in the chemical or pharmaceutical industry, where the wastewater often contains toxic molecules, requires careful attention during start-up phases. Installation of specific probes (methane analyzer or total oxygen demand meter for instance) in industrial full-scale anaerobic digestion plants allow for a quick reaction time in case of digestion failure due to abnormal concentrations of toxic compounds. This permits the anaerobic biomass to be protected against these compounds. (See also W90-03562) (Lantz-PTT)
W90-03586

TREATMENT OF PROCESS WASTEWATER FROM PETROCHEMICAL PLANT USING A ROTATING BIOLOGICAL CONTACTOR: A CASE STUDY.
Royce Process Equipment Co., Inc., Pearland, TX.
W. C. Davis, and T. M. Pankratz.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 472-482, 7 fig, 2 tab, 3 ref.

Descriptors: *Contactors, *Industrial wastes, *Chemical wastewater, *Wastewater treatment, *Chemical industry, *Biological wastewater treatment, Case studies, Microbial degradation, Industrial wastewater, Aeration, Pilot plants, Biological oxidation, Biofilm reactors, Activated carbon, Storm runoff.

A rotating biological contactor (RBC) process can be utilized in virtually any industrial or municipal application where the liquid wastewater characteristics are amenable to biological oxidation. Biological oxidation, in this fixed film process, uses innocuous bacteria, protozoa, and algae to convert the soluble (dissolved) organic pollutants into new cell mass and gaseous by-products. A six month field pilot study, using an RBC, was conducted at a southern petrochemical plant. The purpose of this study was to determine the feasibility of the RBC process as a means of treating a unique industrial wastewater for direct discharge. The pilot study utilized industrial wastewater containing blowdown from an ethane and propane gas cracking furnace quench tower co-mingled with storm water runoff. The polluted wastewater must be treated prior to reuse or discharge. Following startup, and after the establishment of a biofilm on the contactor media, the operating parameters were varied in an effort to determine the optimum operating conditions. Variations included: increasing and decreasing the plant flow rates, varying the speed of shaft rotation, pre-aeration, and the addition of powdered activated carbon. The pilot test results indicated that the RBC can provide effective biological treatment of the industrial wastewater within the requirements of the permit limits. (See also W90-03562) (Lantz-PTT)
W90-03587

LAND TREATMENT OF NITROGUANIDINE WASTEWATER.
Weston (Roy F.), Inc., West Chester, PA.
R. T. Williams, A. R. MacGillivray, and D. E. Renard.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 483-488, 1 tab, 9 ref.

Descriptors: *Munitions wastes, *Biological wastewater treatment, *Soil columns, *Wastewater treatment, *Nitroguanidine, Industrial wastewater, Guanidine nitrate, Ammonia, Nitrates, Sulfates, Cyanamide, Biotransformation, Mineralization.

Nitroguanidine (NQ) wastewaters contain nitroguanidine, guanidine nitrate (GN), ammonia, nitrate, and sulfate. Simulated NQ wastewater is being applied to continuous and perfusion soil columns, with continuous flow column influent and effluent samples being analyzed for wastewater components and transformation products (nitrosoguanidine, guanidine, cyanamide, melamine, and cyanoguanidine). Whey, molasses, and glucose are being tested as carbon supplements. Mineralization rate experiments are being conducted using 14-C-NQ and 14-C-Gn as test substrates. The number of microbes capable of degrading NQ and GN is being determined, as is microflora acclimation. Preliminary data indicate that carbon supplements facilitate NG degradation after 70 days of application in continuous flow soil columns. Batch mineralization experiments generally support these findings. To date, cyanamide is the only transformation product detected in significant quantities. (See also W90-03562) (Author's abstract)
W90-03588

FATE OF COD IN AN ANAEROBIC SYSTEM TREATING HIGH SULPHATE BEARING WASTEWATER.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
G. K. Anderson, J. A. Sanderson, C. B. Saw, and T. Donnelly.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 504-531, 6 fig, 6 tab, 26 ref.

Descriptors: *Chemical oxygen demand, *Anaerobic digestion, *Sulfur, *Sulfates, *Biological wastewater treatment, *Wastewater treatment, Acidic water, Chemical treatment, Sulfur bacteria, Oil industry, Industrial wastewater, Sulfides, Food-processing wastes.

Two pilot plants, an anaerobic contact process and an anaerobic packed bed reactor were operated on site, treating a high sulfate bearing wastewater from an edible oil refinery. The objectives of the research were as follows: to test the amenability of wastewater from the acid water fat trap to treatment in continuously operated anaerobic processes; and to compare the relative performances of two anaerobic process configurations. Results to date show that both anaerobic systems are able to provide stable and reliable treatment of combined acid and margarine water as received from the outlet of the acid water fat trap without the need for chemical treatment to remove fat. Although inhibition of sulfate reducing bacteria (SRB) is technically feasible, the anaerobic reactors can also be operated as binary microbiological systems. This work has shown that anaerobic processes operating on sulfate bearing acid water from edible oil refining, result in the development of a microbial system with sulfate reducing bacteria, rather than methanogenic bacteria as the main terminal group. In order to realize the full treatment potential of the anaerobic process, the sulfides must be stripped from the treated effluent. The resultant biological sulfate reducing systems may then provide a high efficiency of carbonaceous chemical oxygen demand removal at rates at least comparable with methanogenic systems. (See also W90-03562) (Lantz-PTT)
W90-03590

FATE OF 4,6-DINITRO-O-CRESOL IN MUNICIPAL ACTIVATED SLUDGE SYSTEMS.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
H. Melcer, and W. K. Bedford.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 532-541, 1 fig, 4 tab, 8 ref.

Descriptors: *Tracers, *Phenols, *Municipal wastewater, *Activated sludge process, Dinitrocresol, Organic compounds, Biodegradation, Biological wastewater treatment, Retention time, Wastewater facilities.

The paper describes work carried out to calibrate and test experimental protocols used in these experiments and assess the fate of specific toxic and inhibitory organic contaminants in municipal wastewater treatment plants. 4,6-dinitro-o-cresol (DNOC) was selected to serve as a tracer organic compound in view of its low volatility, potential for adsorption and reported resistance to biodegradation. Municipal activated sludge systems operated at a 6-hr hydraulic retention time (HRT) and sludge retention time (SRT) of 5 to 15 days can degrade DNOC from levels in the range 0.3 to 1.2 mg/L to detection limits. At SRTs of < 5 days, DNOC removal is incomplete. Insignificant losses of DNOC by volatilization were observed. The major mechanism of DNOC removal appeared to be by biodegradation accounting for 93% to 98% removal of the DNOC fed to the systems. (See also W90-03562) (Lantz-PTT)
W90-03591

PILOT-SCALE ANAEROBIC BIOMASS ACCLIMATION STUDIES WITH A COAL LIQUEFACTION WASTEWATER.
Dearborn Environmental Consulting Services, Mississauga (Ontario).
D. N. Young, E. B. Vale, and E. R. Hall.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 542-572, 9 fig, 9 tab, 20 ref.

Descriptors: *Pilot plants, *Acclimatization, *Industrial wastewater, *Wastewater treatment, *Biomass, *Coal wastes, *Anaerobic digestion, *Biodegradation, Liquefaction, Chemical oxygen demand, Methane, Granular activated carbon, Phenols, Organic compounds.

Neither readily-biodegradable organic co-substrate addition nor low severity solvent extraction pretreatment improve the acclimation of anaerobic biomass in anhybrid reactors to H-Coal process wastewater. Acclimation to increasing organic loading rates by hydraulic retention time (HRT) reduction at sub-inhibitory feed strengths of the H-Coal wastewater resulted in higher loading rates attained in both the anhybrid and granular activated carbon (GAC) fluidized bed reactors than the alternate strategy of increasing feed strength at long HRT's. The study results show the beneficial effect of GAC media on anaerobic treatment of a toxic wastewater. Maximum organic loading rates of 2.6 kg chemical oxygen demand (COD)/cu m/day at 0.78 days HRT and 21 kg COD/cu m/day at 0.39 days were attained in the anhybrid and GAC fluidized bed reactor respectively over an acclimation period of approximately one year. The overall results indicate that anaerobic treatment of a toxic high-strength phenolic wastewater can be carried out at organic loading rates similar to those used with a readily biodegradable wastewater following a carefully executed acclimation phase. This treatment method should, therefore, be suitable for use as a first-stage bulk organics and detoxification process in a multi-stage treatment system. (See also W90-03562) (Lantz-PTT)
W90-03592

ANOXIC/OXIC ACTIVATED SLUDGE TREATMENT OF CYANOGENS AND AMMONIA IN THE PRESENCE OF PHENOLS.
Pennsylvania Univ., Philadelphia. Dept. of Civil Engineering.
D. J. Richards, and W. K. Shieh.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 573-583, 2 fig, 3 tab, 17 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Ammonia, *Cyanide, *Phenols, Thiocyanates, Organic carbon, Pretreatment of wastewater, Inhibition, Aerobic conditions, Anaerobic conditions, Industrial wastewater, Biological oxidation, Biodegradation.

Petrochemical, steel manufacturing, mining and synthetic fuel processing are among several industries that generate wastewaters containing relatively high concentrations of phenols, cyanide, thiocyanate and ammonia. Despite the fact that wastewaters with this composition are inhibitory to biodegradation, biological oxidation through activated sludge processes is utilized widely to achieve required treatment. Biological treatment usually follows pretreatment methods such as equilization and storage, ammonia stripping, chlorination and air flotation which render the wastewater more amenable to biodegradation. This paper describes an on-going laboratory investigation which evaluates the efficacy of an anoxic/oxic activated sludge system for treating this type of wastewater, with the following objectives: to compare the effect of cyanide concentration increase on an activated sludge system and an anoxic/oxic activated sludge system, and to report on the removal of cyanide and thiocyanate from both systems. The results from this study, to date, indicate that there are several advantages to the anoxic/oxic system over the activated sludge system in handling cyanide, thiocyanate laden phenolic wastewater. Cyanides and thiocyanates are effectively removed in both the activated sludge system and the anoxic/oxic system in the presence of up to 45 mg/L CN(-). Overall total organic carbon (TOC) removal is consistent in both systems. The anoxic/oxic system reacts better to changes in cyanide concentration changes than does the activated sludge unit. The anoxic/oxic system also has an added advantage over the activated sludge system in terms of ammonia-nitrogen removal. It is possible to reduce ammonia-nitrogen to nitrogen gas. (See also W90-03562) (Lantz-PTT)
W90-03593

PARTITIONING OF TOXIC ORGANIC COMPOUNDS ON MUNICIPAL WASTEWATER TREATMENT PLANT SOLIDS.
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
R. A. Dobbs, M. Jelus, and K. Y. Cheng.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 584-600, 5 fig, 4 tab, 22 ref.

Descriptors: *Separation techniques, *Poisons, *Wastewater facilities, *Sludge solids, *Organic compounds, *Sorption, *Solids, *Municipal wastewater, *Wastewater treatment, Hazardous wastes, Kinetics, Biomass, Biological wastewater treatment, Statistical analysis, Biological treatment.

Preliminary studies have shown that partitioning of municipal wastewater treatment plant solids was not affected by solids-to-liquid ratio. Kinetic data on sorption of toxic organic compounds on wastewater treatment plant solids showed an initial rapid uptake followed by a slower rate over an extended period of time. Freeze-dried solids did not exhibit the same sorption characteristics as viable biomass. A correlation between sorption of toxic organics on wastewater treatment plant solids and octanol/water partition coefficient has been established. The relationship should be useful for estimating the removal of toxic organic compounds in municipal and industrial wastewater treatment plants by the sorption mechanism. The correlation also provides a basis for predicting concentrations of toxic compounds in various sludges provided the equilibrium concentration in the aqueous phase is known (or assumed). (See also W90-03562) (Lantz-PTT)
W90-03594

PATAPSCO WASTEWATER TREATMENT PLANT TOXICITY REDUCTION EVALUATION.
Engineering Science, Fairfax, VA.
J. A. Botts, J. W. Braswell, E. C. Sullivan, W. Goodfellow, and B. D. Sklar.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 601-621, 4 fig, 5 tab, 9 ref.

Descriptors: *Wastewater facilities, *Water quality control, *Toxicity, Lethal limit, Comparison studies, Secondary wastewater treatment, Primary wastewater treatment, Waste management, Maryland, Baltimore, Biological wastewater treatment, Performance evaluation, Microbial degradation, Ceriodaphnia, Mysidopsis, Microtox assay.

The US EPA has established a policy to develop water quality based permit limitations to control the discharge of toxic materials through the nation's wastewater treatment systems. A toxics management process is evolving to support this policy and one step in this process involves conducting Toxicity Reduction Evaluations (TREs) at wastewater treatment facilities identified as having toxic influent wastewaters. The objectives of these TREs are to assess the sources of toxicity, the impact of treatment, and the pass-through following treatment of wastewater toxicity. The EPA and the City of Baltimore are conducting a TRE at the City's Patapsco Waste Water Treatment Plant (Patapsco WWTP). The Patapsco TRE was initiated in April 1986 and will provide the first case history of a toxics management program at a municipal wastewater treatment plant. The over-all approach and specific tasks that have been developed since the TRE was proposed are described in this paper. Initial results of the study are also presented and discussed. To date, Ceriodaphnia dubia has been the most sensitive indicator of acute toxicity for both the primary effluent and the secondary effluent wastewaters. The acute responses for Mysidopsis bahia and Microtox have been considerably less sensitive than C. dubia. The Ceriodaphnia were approximately 8 and 9.9 times more sensitive than M. bahia and Microtox, respectively; while M. bahia were approximately 1.5 times more sensitive than Microtox. Results of three toxicity tests show that significant toxicity reduction occurs across the plant's secondary treatment system. The primary effluent was approximately 3.3 times (range of 1.9 to 7.9) more acutely toxic to C. dubia and M. bahia than the secondary effluent. Microtox sowed a greater difference than the other two species, i.e., the primary effluent was approximately 9.6 times (range of 1.8 to 28.6) more toxic than the secondary effluent. (See also W90-03562) (Lantz-PTT)
W90-03595

MICROTOX ASSESSMENT OF ANAEROBIC BACTERIAL TOXICITY.
Massachusetts Univ., Amherst. Environmental Engineering Program.
D. S. Atkinson, and M. S. Switzenbaum.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 622-641, 3 fig, 5 tab, 55 ref. Massachusetts Division of Water Pollution Control Contract 83-31.

Descriptors: *Bioassay, *Anaerobic bacteria, *Microtox assay, *Anaerobic digestion, *Toxicity, *Wastewater treatment, Water quality control, Monitoring, Microbiological studies, Marine bacteria, Laboratory methods, Comparison studies, Bioluminescence, Photobacterium, Literature review.

For improved process monitoring of anaerobic treatment systems which may receive influents of variable composition, it would be useful to have a quick, inexpensive, screening test which could be used as a surrogate to the anaerobic toxicity assay (ATA) test. The Microtox toxicity analyzer, developed by Beckman Instruments provides a means for rapid, inexpensive assessment of toxicity of aqueous samples. The Microtox system is a relatively inexpensive test which employs aerobic bioluminescent marine bacteria (Photobacterium phosphoreum) and can yield reproducible results within one hour. Good correlations between Microtox and rat, fish, daphnia, shrimp, algal, and other aerobic bacterial bioassays have been reported in the literature. The primary objective of the research in this paper is to determine whether the Microtox system can be used as a suitable surrogate test for the longer ATA test. The study was conducted in two parts. The available literature on both anaerobic toxicity and Microtox testing was reviewed and the reported laboratory tests using both toxicity methods were also performed. The results do not indicate that Microtox would be expected to serve as a particularly good surrogate for the ATA for monitoring potentially toxic wastes entering an anaerobic treatment unit. The Microtox may have an application for monitoring waste streams which may be subject to inorganic toxicants but are unlikely to be contaminated with organic toxicants. (See also W90-03562) (Lantz-PTT)
W90-03596

RESPIRATION-BASED EVALUATION OF NITRIFICATION INHIBITION USING ENRICHED NITROSOMONAS CULTURES.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
J. E. Alleman.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 642-650, 5 fig, 1 tab, 77 ref.

Descriptors: *Inhibition, *Pollutant identification, *Water quality control, *Nitrosomonas, *Nitrification, *Respiration, *Wastewater treatment, *Bioassay, Microbiological studies, Colorimetry, Respirometry, Ammonia, Nitrogen, Performance evaluation, Monitoring, Oxygen uptake.

The enriched Nitrosomonas bioassay procedure described in this paper is proven to be an extremely useful, expedient, and cost-effective mechanism for the rapid evaluation of wastewater toxicity. Extending beyond this immediate application, the procedure has been employed for investigative evaluations of suspected industrial waste genera-

tors. Furthermore, this test has been successfully used to diagnostically determine appropriate dilution levels for industrial waste streams at their respective sewer outfalls. Although this bioassay may be completed with either respirometric (based on oxygen uptake rate (OUR)) or colorimetric (based on NH4-N oxidation rates) analyses, the oxygen uptake rate (OUR) strategy appears preferable due to its simplicity. Monitoring of the ammonium-nitrogen oxidation rate with a colorimetric NH4-N test requires tedious sample clarification and treatment. Within an eight hour workday, two laboratory technicians can routinely complete between 100 and 120 bioassay tests based on the OUR procedure; this number of samples is approximately four times larger than that which can be managed with the colorimetric procedure. As with any bioassay procedure, questions may be raised about the inherent reliability and veracity of the tests. In the particular case of its use by the City of Indianapolis, however, the enriched Nitrosomonas bioassay technique has proven to be an excellent 'indicator' procedure. (See also W90-03562) (Lantz-PTT)
W90-03597

ASSESSMENT OF THE DEGREE OF TREATMENT REQUIRED FOR TOXIC WASTEWATER EFFLUENTS.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
G. F. Lee, and R. A. Jones.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 651-675, 26 ref.

Descriptors: *Toxicity, *Wastewater treatment, *Water quality control, *Water pollution prevention, *Industrial wastewater, *Regulations, Water pollution effects, Public health, Environmental effects, Activated carbon, Hazardous wastes, Water quality standards, Domestic wastes.

The amount of treatment that will be required for a particular wastewater (domestic, industrial, or hazardous waste) and the assessment of the adequacy of treatment provided are now coming to be controlled by the amounts of contaminants allowable without adversely affecting the aquatic life-related or public health-related beneficial uses of the receiving water. These concerns will in some instances dictate the type of treatment processes that must be used to achieve the desired degree of treatment as well as the siting of the treatment facilities. The US EPA has recommended an approach that is designed to begin to address the evaluation and testing issues pertinent to this type of effluent evaluation approach. The approach being used is to limit the 'toxicity' of wastewater treatment plant effluents and other discharges; the premise is that if the effluent discharged is nontoxic there is limited likelihood of there being toxicity in the receiving water. While there are a number of significant problems with the implementation of this approach in providing cost-effective treatment which will still provide adequate environmental and public health protection in receiving waters, it does represent a significant step toward the regulatory agencies' developing technically defensible control programs for toxics. Following the current (September 1985) EPA guidance may result in a discharger's treating an effluent to a considerably greater degree than necessary to provide protection of aquatic life-related beneficial uses of the receiving water, or inadequate treatment to achieve this protection. In the opinion of the authors, because of the fact that effluents from hazardous waste treatment facilities will contain a significant number of contaminants which may be highly hazardous to man and the environment, and for which there are no criteria or standards, it is appropriate that the wastewater effluent from such facilities be processed through two activated carbon columns in series. Such an approach should significantly increase the environmental and public health protection afforded by the hazardous waste treatment facility beyond that normally required today. (See also W90-03562) (Lantz-PTT)
W90-03598

BALLAST WATER TREATMENT PLANT.
National Ocean Service, Anchorage, AK. Ocean Assessments Div.
M. J. Hameedi.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 17-38, 5 fig, 2 tab, 17 ref.

Descriptors: *Ballast water, *Wastewater treatment, *Oily water, *Arctic zone, *Valdez, *Alaska, Water pollution prevention, Oil pollution, Physical treatment, Chemical treatment, Flocculation, Sludge.

A ballast water treatment plant operates as part of the Alyeska Pipeline Service Company's marine terminal on the southern shore of Port Valdez, Alaska. The plant receives ballast water from oil tankers arriving at the terminal. The ballast water contains small amounts of petroleum, usually < 1%, and other related pollutants. The plant is designed to treat and remove oil and grease from the ballast water in order to meet permit requirements for the discharge of wastewaters in Port Valdez. The plant processes nearly 51,000 cu m of ballast water/day using quiescent aging of ballast water in settling tanks and mechanical removal of free oil as a primary treatment. Secondary treatment consists of chemically aided flocculation followed by aeration to remove oil and grease as floating scum. There are three principal streams: (1) the water treatment stream from settling tanks for primary treatment to eventual disposal of the effluent through a diffuser pipe in Port Valdez; (2) the separated oil stream for recovered oil from settling tanks to crude oil storage tanks; and (3) the waste stream consisting of floating scum and oily sludge from various processing units to ballast water storage and skimmer tanks. Recent investigation by the two primary permitting agencies--the US EPA and the State of Alaska Department of Environmental Conservation--as well as other data, have claimed that the plant has not operated in conformity with its original design or with provisions of the discharge permit. The available discharge monitoring data do not show evidence of uncontrolled discharge of pollutants into port. A number of design and procedural changes have been made, some of which are clearly beneficial to the operation of the plant. Since the plant was designed primarily to remove suspended oil and grease from the ballast water, it does not effectively remove dissolved pollutants. A few toxic substances which are known to be present in the effluent, i.e., naphthalene and toxic metals, have not been controlled through the operating permits. (See also W90-03610) (Lantz-PTT)
W90-03612

ZEOLITE AMMONIA REMOVAL FROM CATFISH POND WATERS.
Mississippi Univ., University. Dept. of Chemical Engineering.
C. W. Williford, M. Quiros, and W. R. Reynolds.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 33-38. 2 fig, 4 tab, 7 ref.

Descriptors: *Catfish ponds, *Aquaculture, *Wastewater treatment, *Zeolite process, *Water treatment, *Water quality control, *Ammonia, Pond water, Fish ponds, Fisheries, Toxicity, Filtration, Ion exchange, Regeneration, Model studies, Hardness, Ammonium, Calcium, Magnesium, Algae.

The natural zeolite clinoptilolite has been shown to be very effective at removing dilute ammonia from water. The design concerns were addressed for the use of clinoptilolite in a filtration system to remove ammonia from catfish pond waters. The ammonia uptake characteristics of clinoptilolite, including dynamic ion exchange, total exchange capacity, and regeneration, were determined using model solutions and pond waters. Design control data, such as pressure drop, ammonia capacity, and the required frequency of regeneration for the components of a clinoptilolite ammonia removal system, were gathered. Finally, components of a small scale ammonia removal system were integrated and tested. It was found that clinoptilolite exhibits ion exchange and wet mechanical strength suitable for ammonia removal from low concentration solutions. Ammonia removal from dilute monoionic, 1 ppm NH4(+) solution is excellent with a typical capacity of 1.48 meq/g zeolite. The zeolite can be effectively regenerated over a three hr period with a flow of 15 bed volumes/hr of 0.35 molar NaCl. Water hardness causes a significant reduction in ammonia uptake capacity. This chiefly results from competition of Ca(2+) and Mg(2+) ions with the NH4(+) ions for exchange sites. Use of pond water causes further reduction possibly related to organics and algae present. However, algae does not present a major problem for filtration. Backflushing effectively removes filtered algae. (See also W90-03708) (Friedmann-PTT)
W90-03714

WATER QUALITY MANAGEMENT FOR PH CONTROL.
Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
For primary bibliographic entry see Field 5G.
W90-03717

TECHNICAL SUPPORT DOCUMENT: PATHOGEN/VECTOR ATTRACTION REDUCTION IN SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136618. Price codes: A04 in paper copy, A01 in microfiche. 1988. 57p, 60 ref.

Descriptors: *Water pollution control, *Wastewater treatment, *Water pollution prevention, *Pathogens, *Sludge, *Regulations, Viruses, Protozoa, Public health, Bacteria, Helminths.

The technical background and justification for the EPA's proposed regulation (40 CFR Part 504) on pathogen and vector attraction reduction in municipal wastewater sludge (Subpart F) and the existing 40 CFR 257 Federal regulations for controlling pathogens and vector attraction in sludge are summarized. The various components of disease risk, including the pathogens of concern (bacteria, viruses, protozoa, and helminths), their types, measurement, environmental fate and transport, and infective dose are also reviewed as well as effects of various processing. Principal aspects of the proposed new regulations concerning sludge pathogen and vector attraction control involve shifting from technology-based to performance-based standards, separating the requirements for pathogen reduction and reduction of vector attraction, incorporating the contribution of wastewater treatment to pathogen reduction, and establishing new regulations for well-stabilized sludges. The scientific basis of the proposed regulation is presented following the exact format of the regulation. Each topic discussed is keyed into the numbering system used in the regulation. (Lantz-PTT)
W90-03755

TECHNICAL SUPPORT DOCUMENT: INCINERATION OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5E.
W90-03766

MUNICIPAL WASTEWATER CONVEYANCE AND TREATMENT: TECHNOLOGICAL PROGRESS AND EMERGING ISSUES, 1988.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-143390. Price codes: A04 in paper copy, A01 in microfiche. September 1988. 644p, 18 fig, 2 tab, 5 append.

Descriptors: *Municipal wastewater, *Wastewater treatment, *Technology, Land disposal, Activated sludge processes, Trickling filters, Wastewater collection, Corrosion, Sulfides, Regulations.

Since 1983, EPA has issued annual 'Innovative and Alternative Technology Progress Reports' to document the technical accomplishments of the Innovative and Alternative (I/A) program. This year, in response to the challenges faced implementing the 1987 Water Quality Act (WQA), EPA is refocusing the annual technology progress report. A Report to Congress on the Effectiveness of the Innovative and Alternative Wastewater Treatment Technology Program is also being prepared. The WQA of 1987 affects the municipal wastewater pollution control field in a number of significant ways. These include changes in methods of financing municipal sewerage works construction, identification and control of toxic pollutants and establishing regulatory programs for sewage sludge. This report is intended to provide an overview of technical progress not only under I/A program, but in the broader municipal technology field as well. In addition to discussing progress in I/A technologies such as land treatment, sequencing batch reactors, and alternative collection systems, the report also discusses progress in conventional technologies such as activated sludge, trickling filters, and collection system rehabilitation. This report also discusses emerging issues in the municipal wastewater field such as toxics control, sulfide corrosion of sewers, and new sludge regulations. (Lantz-PTT)
W90-03767

FIELD MEASUREMENTS OF FULL-SCALE HAZARDOUS WASTE TREATMENT FACILITIES--ORGANIC SOLVENT WASTES.
Metcalf and Eddy, Inc., Wakefield, MA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-138853. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/2-88/073, January 1989. 214p, 25 fig, 61 tab. EPA Contract 68-03-3166.

Descriptors: *Field tests, *Hazardous wastes, *Organic compounds, *Waste treatment, *Wastewater treatment, *Solvents, Distillation, Evaporation, Incineration, Adsorption, Activated sludge processes.

Treatment of organic wastes by full scale treatment facilities was evaluated through field evaluations of off-site hazardous waste treatment facilities to provide data regarding alternative treatment technologies to land disposal and the applicability of these technologies to specific waste streams. Field sampling and analysis provided characterization of the waste, product and residues associated with technologies such as distillation, steam distillation, thin film evaporation, heated screw auger evaporation, incineration, steam stripping, waste blending, carbon adsorption, and activated sludge treatment at the facilities tested. An evaluation of treatment effectiveness based on waste, product, and residue characteristics and a discussion on residue management were prepared for each facility. (Author's abstract)
W90-03768

PROPOSED BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT: FOR WASTES FROM THE PRODUCTION OF DINITROTOLUENE, TOLUENEDIAMINE, AND TOLUENE DIISOCYANATE.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-1142285. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/530-SW-89-017773, December 30, 1988. 78p, 2 fig, 11 tab, 40 ref, 2 append.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Toluenes, *Waste treatment, *Standards, *Dinitrotoluene, Toluenediamine, Toluene diisocyanate, Nickel, Wastewater treatment facilities, Organic compounds.

This background document provides EPA's rationale and technical support for the proposed treatment standards for the listed wastes identified in 40 CFR 261.31 as K277, K113, K114, K115, K116, U221, and U223. K0277, which is generated from the production of toluene diisocyanate (TDI), is part of the second-third of the scheduled listed wastes to be evaluated by the EPA for land disposal restrictions. Wastes listed as K111, K112, K113, K114, K115, and K116, which are generated from the production of dinitrotoluene (DNT), toluenediamine (TDA), or toluene diisocyanate (TDI), are 'newly listed'. In addition, the EPA is proposing treatment standards for soft-hammered first-third U wastes, U221, and U223. This proposed regulation also addresses K027, K113-K116, U221, and U223 wastewaters generated from RCRA corrective actions (as either contaminated ground or surface water). The EPA is proposing treatment standards of incineration and fuel substitution as the specific best demonstrated available technology (BDAT) methods of treatment for K026, K113, K114, K115, K116, U221, and U223) nonwastewaters and wastewaters other than scrubber waters. This document presents EPA's documentation that the demonstrated treatment technologies, incineration and fuel substitution for nonwastewaters and carbon adsorption for wastewaters, provide substantial treatment of hazardous constituents in the K027, K113-K116, U221, and U223 treatability group based on a review of treatment performance data for other wastes. Section 2.0 of this document presents information on the industry affected and waste characterization data available for K027, and K111-K116. Section 3.0 presents the applicable and demonstrated treatment technologies for the treatability groups while Section 4.0 presents treatment performance data used in determining BDAT for the treatability groups. Section 5.0 explains EPA's proposed determination of BDAT for the treatability groups. Section 6.0 discusses the selection of nickel being proposed for regulation in K115 and Section 7.0 explains the calculation of the proposed treatment standard for nickel in K115. The rationale for addressing the K111 and K112 treatability group at a later date is discussed in Section 8.0 (Lantz-PTT)
W90-03769

ARTHUR YOUNG GUIDE TO WATER AND WASTEWATER FINANCE AND PRICING.
Young (Arthur) and Co., Charlotte, NC.
For primary bibliographic entry see Field 6C.
W90-03810

ONSITE WASTEWATER DISPOSAL.
New Mexico Environmental Improvement Agency, Santa Fe.
For primary bibliographic entry see Field 5E.
W90-03811

DYNAMIC MODELING AND EXPERT SYSTEMS IN WASTEWATER ENGINEERING.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
G. G. Patry, and D. Chapman.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 395 p.

Descriptors: *Wastewater treatment, *Model studies, *Sanitary engineering, Waste management, Wastewater management.

This book is the result of a workshop held at McMaster University (May 19-20, 1988), at which a select group of authors and participants were invited to share their experiences. Brought together is current work on dynamic modeling and expert systems as applied to the design, operation, and control of wastewater treatment systems. The book is divided into three major sections: (1) dynamic modeling of wastewater treatment systems including receiving water body interactions; (2) the application of expert systems to wastewater engineering; and (3) system identification and control. (Lantz-PTT)
W90-03812

RECOVERY TECHNIQUES AND TREATMENT TECHNOLOGIES FOR PETROLEUM AND PETROLEUM PRODUCTS IN SOIL AND GROUNDWATER.
Dragun Corp., Berkley, MI.
For primary bibliographic entry see Field 5G.
W90-03845

BIOTECHNOLOGICAL ADVANCES IN PROCESSING MUNICIPAL WASTES FOR FUELS AND CHEMICALS.
Proceedings of the Symposium on Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals held in Minneapolis, Minnesota, on Aug. 15-17, 1984. Noyes Data Corporation, Park Ridge, New Jersey. 1987. Edited by A.A. Antonopoulos. 488p.

Descriptors: *Waste treatment, *Municipal wastes, *Waste disposal, *Waste recovery, *Waste management, *Wastewater treatment, Wastewater management, Wastewater renovation, Biotransformation, Fuel, Methane.

A symposium was held in late 1984 by a forum of experts in various related fields having to do with the bioconversion of municipal-wastes to fuels and other valuable chemicals. The primary emphasis is on understanding the physiology, biochemistry, and genetics of microbes involved in anaerobic digestion; the various microecological interactions; the biological production of fuels and chemicals; and the generation and extraction of landfill gas. The current status of the field is assessed and research perspectives are offered. The use of biotechnology in processing waste could be an important tool for environmental engineers. (See W90-03851 thru W90-03872) (White-Reimer-PTT)
W90-03850

DEVELOPMENT OF IDEAS ON THE NATURE AND AGENTS OF BIOMETHANOGENESIS.
California Univ., Davis. Dept. of Bacteriology.
R. E. Hungate.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 1-14. 46 ref.

Descriptors: *Methane, *Methane bacteria, *Biodegradation, *Waste treatment, *Wastewater treatment, *Microbial degradation, History, Cellulose, Culturing techniques.

Methanogenesis depends not only on methanogenic bacteria but also on bacteria that decompose plant materials. The nature of the methanogens and also of the cellulolytic bacteria was a mystery to early microbiologists because of the lack of easily obtainable and conserved pure cultures. With the improvement of anaerobic chambers to the point that methanogens can be grown in them on plates, the cultivation and direct isolation of methanogenic bacteria in pure culture has become frequent. It is impossible to predict which of the advances in the understanding of the detailed mechanisms of methanogenesis and their bacterial agents will lead to better exploitation of this process. Practical methanogenesis depends not only on the knowledge of the organisms and the processes they effect, but also on the nature of the materials, chiefly plant cell walls, they must use. A very large proportion of plant material is not readily digestible by presently known enzymes or microbes to products that can serve as substrates for methanogenesis. Plant materials readily digestible and fermentable to methane may constitute also a favorable source of food for ruminants, and ruminants, producing high quality protein, also represent conserved energy, in this case in the form of food rather than power. Wise social, economic and political judgments are needed for a judicious allocation of resources to these various demands. (See also W90-03850) (Author's abstract)
W90-03851

ACETATE METABOLISM BY METHANOSARCINA.
Wisconsin Univ., Madison. Dept. of Bacteriology.
J. A. Krzycki, and J. G. Zeikus.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 15-34. 3 fig, 3 tab, 68 ref.

Descriptors: *Methane, *Methane bacteria, *Biodegradation, *Waste treatment, *Wastewater treatment, *Microbial degradation, Acetates, Chemical reactions, Synthesis, Methanogenesis, Adenosine triphosphate, Methanosarcina, Metabolites.

Acetate metabolism is a key process in methanogens. Methanosarcina barkeri forms methane by the following reactions during growth on acetate as energy source: CH3COOH to CH4 + CO2. In addition, acetate or an acetyl derivative is synthesized as an early cell carbon precursor by M. barkeri growing on one carbon compounds. Both biodegradation and synthesis of acetate appear to share common biochemical features such as the involvement of methyl-CoM, methyl-B12, and the enzyme carbon monoxide dehydrogenase. Methanogenesis from acetate occurs via two mechanisms; a primary route where methane is derived from an intact methyl group, and a secondary pathway where methane is formed by coupling methyl group oxidation to the reduction of the carboxyl group. A unifying hypothesis for ATP synthesis during methanogenesis from acetate by the primary route is proposed and is based on information obtained from the substrate dependent regulation of carbon monoxide dehydrogenase activity, characterization of the purified enzyme, and analysis of methane production from acetate in cell-free extracts. The hypothesis suggests that an acetyl derivative is metabolized to methyl-CoM and a carbonyl intermediate. The latter is oxidized to CO2 by carbon monoxide dehydrogenase. The electrons produced are transferred along a membrane bound electron transport chain and used to reduce methyl-CoM to methane. ATP synthesis is then coupled to the free energy of the resultant proton motive force. (See also W90-03850) (Author's abstract)
W90-03852

ACETOCLASTIC METHANOGENS IN ANAEROBIC DIGESTERS.
Institut National de la Recherche Agronomique, Massy (France). Station de Technologie Alimentaire.
J. P. Touzel, and G. Albagnac.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 35-39. 2 tab, 7 ref.

Descriptors: *Wastewater treatment, *Methane, *Anaerobic digestion, *Methane bacteria, Methanothrix, Methanosarcina, Morphology, Acetates, Metabolites.

Four different strains of methane bacteria that convert acetate into methane have been isolated from anaerobic digesters. With the exception of Methanothrix soehngenii which is commonly seen in anaerobic digester sludges, the occurrence of Methanosarcina sp. as major acetoclastic methanogens in such systems needs further investigation. However, the morphological changes induced by the culture medium in some Methanosarcina strains could have been misleading for observers looking for sarcina-like organisms, as already noticed by previous researchers. All the isolates are characterized by their inability to produce methane from H2+CO2. Among other features, the occurrence of granular cytoplasmic inclusions, possibly of a polyosidic nature, have been evidenced in all the Methanosarcina isolates along with tubular (core-like) structures in the thermophilic strains only. From a technological point of view, the kinetic characteristics favor the mesophilic processes when an efficient acetate conversion into methane has to be reached as is the case in wastewater treatment. (See also W90-03850) (Author's abstract)
W90-03853

METABOLISM OF H2 AND CO2 BY METHANOBACTERIUM.
Marburg Univ. (Germany, F.R.). Fachbereich Biologie.
P. Schonheit, and R. K. Thauer.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 41-51. 3 fig, 69 ref.

Descriptors: *Methane, *Methane bacteria, *Biodegradation, *Waste treatment, *Wastewater treatment, *Microbial degradation, Hydrogen, Carbon dioxide, Metabolites, Adenosine triphosphate, Acetyl CoA.

Methanobacterium species grow on H2 and CO2 as sole energy source: 4H2+CO2 to CH4+2H2. Per mol of methane formed from CO2 about 1 mol of ATP is generated. Coupling is probably via the chemiosmotic mechanism. The reduction of CO2 to methane proceeds via carrier bound intermediates involving methanofuran, tetrahydromethanopterin, CoM, component B, and a nickelporphinoid as coenzymes. Most methanobacteria can grow on CO2 as sole carbon source; i.e., they are autotrophs. Acetyl-CoA rather than 3-phosphoglycerate has been identified as an early CO2 fixation product. Evidence has accumulated that acetyl-CoA is formed in a carbonylation reaction with a methyl-corrinoid and a acetyl-corrinoid as intermediates. Acetyl CoA synthesis in autotrophic methanogens and in acetogenic bacteria appears to be mechanistically similar in many respects. Both CO formation and acetate synthesis were inhibited by cyanide. (See also W90-03850) (Author's abstract)
W90-03854

EFFECT OF HYDROGEN CONCENTRATION ON POPULATION DISTRIBUTION AND KINETICS IN METHANOGENESIS OF PROPIONATE.
Stanford Univ., CA. Dept. of Civil Engineering.
P. L. McCarty, and D. Smith.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 53-66. 6 fig, 1 tab, 24 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Methane, *Methane bacteria, *Biodegradation, *Microbial degradation, Propionates, Substrate utilization, Partial pressure, Model studies, Metabolites.

The recent recognition of the significance of acetogenic dehydrogenation as a major stage in methanogenesis of complex substrates has led to questions about the current understanding of bacterial growth and the kinetics of substrate utilization. The implications of the third stage in methanogenesis are explored through consideration of the growth and kinetics associated with the conversion of propionate, a most important intermediate, to methane. This conversion requires the association of three separate species of bacteria in a manner similar to that for ethanol. The complexity of the ecology that results from separate hydrogen production and utilization within the system requires a new approach to modeling these complex systems. In models commonly used to describe bacterial growth, coefficients of yield are generally taken to be constant. However, with hydrogen consuming methanogens, the yield would be expected to vary considerably with the hydrogen partial pressure. Also, better information is needed on the substrate affinity (Km) of the hydrogen utilizing methanogens because of the significance this has on the effective partial pressure of hydrogen in the system. These are important avenues for further exploration in this interesting and important ecological system. (See also W90-03850) (White-Reimer-PTT)
W90-03855

ENERGETICS OF H2-PRODUCING SYNTROPHIC BACTERIA.
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
P. S. Beaty, M. J. McInerney, and N. Q. Wofford.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 67-83. 4 fig, 2 tab, 26 ref. U.S. Department of Energy Contract No. DE-AS05-83ER13053.

Descriptors: *Waste treatment, *Wastewater treatment, *Anaerobic digestion, *Methane, *Methane bacteria, *Biodegradation, *Microbial degradation, Fermentation, Propionates, Fatty acids, Acetates, Hydrogen, Carbon dioxide, Methanospirillum, Syntrophomonas.

The complete anaerobic degradation of organic matter to CO2 and CH4 requires the concerted action of four major metabolic groups of bacteria. Fermentative bacteria hydrolyze the substrate polymers and ferment the products to volatile acids, CO2 and H2. The H2(-) and acetate producing syntrophic bacteria degrade propionate and longer-chain fatty acids and some aromatic acids to acetate, CO2 and H2. The acetogenic bacteria produce acetate and sometimes butyrate from H2/CO2, CO, CH3OH and methyoxy moieties of aromatic compounds. Finally, the methanogens use the H2 produced by the other groups to reduce CO2 and CH4, and some species cleave acetate to CH4 and CO2. Little is known about the physiology of the H2(-) and acetate-producing syntrophs. These bacteria grow very slowly and only grow in coculture with H2(-) using bacteria. Methods have been developed to mass-culture Syntrophomonas wolfei in coculture with Methanospirillum hungatei and to obtain cell-free extracts of S. wolfei with minimal contamination from cellular components of the methanogen by lysozyme treatment. S. wolfei extracts contained high specific activities of the B-oxidation enzymes indicating that fatty acids are degraded by this pathway. Theoretical calculations indicate that end-product excretion may be an important route for energy production in this organism. (See also W90-03850) (Author's abstract)
W90-03856

THERMODYNAMICS OF CATABOLIC REACTIONS IN THE ANAEROBIC DIGESTOR.
California Univ., Los Angeles. School of Public Health.
D. R. Boone.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 85-96. 6 fig.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Microbial degradation, *Biodegradation, *Thermodynamics, Catabolic reactions, Fermentation, Hydrogen, Substrates, Metabolites.

Anaerobic digestion of organic matter takes place in a stepwise manner with interacting physiological groups of organisms which catalyze successive reactions. The products of one reaction are the substrates for the next, and consequently concentration of any intermediate depends on a balance between its rate of production and rate of degradation. Since many of the reactions of anaerobic digestion yield very small quantities of free-energy, the concentrations of both products and reactants are important. These concentrations can determine whether and to what extent a reaction is exergonic, and thus whether organisms catalyzing that reaction can thrive in the ecosystem. Inefficient degradation of a given fermentation product by subsequent metabolic groups causes that product to accumulate. Elevated concentrations of the product, for instance a fermentation acid, may make its formation relatively less favorable, and other fermentation reactions gain preference. Molecular hydrogen is an important intermediate in this respect; because of its low concentration in digestors it has a very rapid turnover, and its concentration changes rapidly and drastically with small changes in the rate of its production or removal. Hydrogen is an important intermediate in other respects as well: it is a product of many different fermentations, and is the precursor to about 30% of the methane formed in anaerobic digestors. Where hydrogen production is rapid and localized, for instance in organic particles, it may accumulate and inhibit hydrogen-producing reactions. Measurement of hydrogen in digestor systems may not reflect this type of concentration gradient. (See also W90-03850) (Author's abstract)
W90-03857

LINK BETWEEN HYDROGEN AND SULFUR METABOLISMS IN METHANOSARCINA BARKERI (DSM 800).

CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France).
G. Fauque, M. Teixeira, I. Moura, A. R. Lino, and P. A. Lespinat.

IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 97-111. 3 fig, 3 tab, 31 ref.

Descriptors: *Wastewater treatment, *Methane, *Methane bacteria, *Microbial degradation, *Biodegradation, *Culturing techniques, Hydrogenase, Methanosarcina, Substrates, Hydrogen, Physiology, Desulfovibrio, Desulfuromonas.

The hydrogenase of the acetoclastic methanogenic bacterium Methanosarcina (M.) barkeri strain DSM 800 grown on methanol has been purified to homogeneity. This soluble hydrogenase has a high molecular weight (800 kDa) and a final specific activity of 270 micromoles of H2 evolved per min. per mg of protein. It shows an absorption spectrum typical of a non-heme iron protein with a ratio A400/A275 = 0.29. It contains 8-10 iron atoms, 0.6-0.8 nickel atoms and 1 FMN per subunit of molecular weight of 50 kDa. Under hydrogen the purified hydrogenase can reduce the F420 cofactor (either free or protein-bound) and the ferredoxin isolated from M. barkeri as well as cytochromes c553 and c3 from Desulfovibrio and c7 from Desulfuromonas. M. barkeri presents also sulfite, thiosulfate and trithionate reductases activities. The M. barkeri sulfite reductase has been isolated (P590); it contains 0.9 moles of siroheme and 4.9 g atom of iron per subunit of molecular weight = 23 kDa. The EPR spectrum of P590 exhibits characteristics of low spin ferriheme with g values at 2.40, 2.30 and 1.88. (See also W90-03850) (Author's abstract)
W90-03858

ASSIMILATORY REDUCTION OF N2 AND NO3 BY METHANOCOCCUS THERMOLITHOTROPHICUS.

Iowa Univ., Iowa City. Dept. of Microbiology.
N. Belay, R. Sparling, and L. Daniels.

IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 113-123. 2 fig, 1 tab, 16 ref. National Institute of Health Grant No. GM-30868, N.S.F. Grant No. PCM82-07809, and Petroleum Research Fund of the American Chemical Society Grant No. 14062-AC5.

Descriptors: *Wastewater treatment, *Culturing techniques, *Methane, *Biodegradation, *Microbial degradation, *Nitrogen, Acetylene, Ethylene, Methanococcus, Nitrogen fixation.

Methanococcus thermolithotrophicus growing on formate as an energy source used dinitrogen (N2) as the nitrogen source, as evidenced by increase in culture turbidity, protein concentration and methanogenesis. No growth occurred in control cultures lacking N2 or added NH4(+). Acetylene reduction assays for nitrogenase using 0.3% acetylene with cells that were producing methane from formate under N2-fixing conditions showed the production of ethylene; cells grown on NH4(+) as the nitrogen source did not reduce acetylene. Mc. thermolithotrophicus also grew using NO3(-) as the nitrogen source. This organism is the first methanogen, archaebacterium or thermophile growing above 60 degrees C that has been demonstrated to carry out dinitrogen fixation. (See also W90-03850) (Author's abstract)
W90-03859

DEFINED STARTER CULTURE FOR BIOMETHANATION OF PROTEINACEOUS WASTES.

Wisconsin Univ.-Madison. Dept. of Bacteriology.
M. K. Jain, and J. G. Zeikus.

IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 125-139. 4 fig, 4 tab, 26 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Biodegradation, *Microbial degradation, *Methane bacteria, *Methane, Methanosarcina, Clostridium, Acetates, Culturing techniques, Metabolites.

A stable, defined mixed culture was developed which readily degraded gelatin and other proteins into methane and carbon dioxide. The mixture comprised of Methanosarcina barkeri and a novel proteolytic, hydrogen consuming acetogen, Clostridium proteolyticum sp. nov. C. proteolyticum was isolated from a sewage digestor as a prevalent hydrolytic species and its general cellular, growth and metabolic properties are described. In monoculture, C. proteolyticum produced both protease and collagenase activity and fermented all the amino acids in gelatin, except proline, into acetate and carbon dioxide as the main products with hydrogen, isovalerate and isobutyrate detected in trace products (<1 mM). In co-culture with M. barkeri, gelatin was completely hydrolyzed and transformed into methane and carbon dioxide with varying levels of intermediary acetate formed as a function of incubation time. The data show that complex proteinaceous polymers can be readily transformed into methane and carbon dioxide at 30-40 degrees C by a stable co-culture which does not require exogenous growth factor additions. In addition, the co-culture was readily transferable and methanogenesis initiated rapidly without the need for exogenous pH control. (See also W90-03850) (Author's abstract)
W90-03860

STRATEGIES FOR THE ISOLATION OF MICROORGANISMS RESPONSIBLE FOR POLYPHOSPHATE ACCUMULATION.

Brandeis Univ., Waltham, MA. Rosenstiel Basic Medical Sciences Research Center.
N. Suresh, R. Warburg, M. Timmerman, J. Wells, and M. Coccia.

IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 141-161. 7 fig, 3 tab, 31 ref.

Descriptors: *Wastewater treatment, *Biodegradation, *Microbial degradation, *Sludge digestion, *Phosphates, Polyphosphates, Culturing techniques, Acinetobacter, Pseudomonas, Metabolites.

Several strategies were used to isolate organisms involved in the uptake and subsequent release of inorganic phosphate from waste water sludge. These included direct staining for polyphosphates (polyP), growing in 32P inorganic phosphate followed by autoradiography, resistance to dicyclohexyl carbodiimide (DCCD), an ATPase inhibitor, and isolation on the basis of the buoyant density of the cell. Among those microorganisms isolated, three were identified as Acinetobacter lwoffii, A. calcoaceticus and Pseudomonas vesicularis. The P. vesicularis culture had 31% of phosphate as polyP. 31P NMR analysis of the whole cells revealed the presence of polyP when the cultures were grown aerobically to the late stationary phase and its subsequent loss during anaerobic incubation. Loss of polyP was also associated with a decrease in buoyant density of the cell. In the presence of DCCD, there was a decrease in the polyP peak, but a substantial increase in the sugar phosphates which is consistent with a hypothesis that polyP is used as a reserve energy source. P. vesicularis cells showed a two-fold increase in the level of polyphosphatase during early stationary phase, but a thirty-fold increase in polyphosphate kinase activity during late stationary phase. This increased enzyme activity is consistent with the increased polyP synthesis during the late stationary phase. (See also W90-03850) (Author's abstract)
W90-03861

HYBRIDIZATION OF DNA FROM METHANOGENS WITH EUBACTERIAL PROBES.

Institut Pasteur, Paris (France). Dept. de Biochimie et Genetique Moleculaire.
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IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 163-173. 2 fig, 2 tab, 22 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Methane bacteria, *Bacterial physiology, *Microbial degradation, DNA, Homologies, Hybridization, Genetics.

By using the Southern hybridization technique, homologies were examined between restricted DNA of Methanobacterium ivanovi, Methanococcus voltae, Methanosarcina barkeri, Methanobacterium thermoautotrophicum strain Delta H and several eubacterial probes. No hybridization was observed with the following genes: Escherichia coli cya (adenylate cyclase), E. coli and Anabaena glnA (glutamine synthetase), Bacillus subtilis gyrAB (gyrase), and Rhizobium japonicum hup (hydrogenase uptake). Positive results were obtained with B. subtilis rRNA genes and Klebsiella pneumoniae and Anabaena nifH genes that code for the subunit of nitrogenase Fe protein. The finding of homology among these organisms at the rRNA gene level is a preliminary step in the characterization of these genes in methanogens. (See also W90-03850) (Author's abstract)
W90-03862

NUTRIENT REQUIREMENTS FOR ANAEROBIC DIGESTION.

Drexel Univ., Philadelphia, PA.

For primary bibliographic entry see Field 5E.
W90-03863

PROPIONATE CONVERSION TO BUTYRATE IN AN ANAEROBIC DIGESTER.

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E. Samain, R. Moletta, H. C. Dubourguier, and G. Albagnac.

IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 223-233. 6 fig, 1 tab, 9 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Microbial degradation, *Sludge digestion, Propionates, Butyrates, Acetates, Metabolites.

During batch degradation of propionate by anaerobic sludge or by a highly purified culture, a transient accumulation of acetate and butyrate was observed. Labeling experiments and inhibition of methanogenesis by bromoethane sulfonic acid evidenced that butyrate is a facultative electron sink during acetogenesis rather than an end-product of acetate fermentation by butyric bacteria. The synthesis of butyrate and acetate during batch degradation of propionate, either by anaerobic sludge or by a highly purified culture is reported. The purified culture on propionate still contains butyrate degraders. This may be explained by the synthesis of butyrate during batch degradation of propionate which allows maintenance of butyrate-degrading organisms which are present in high numbers in the digester microflora. The results of labeling experiments with the digester sludge strongly suggest that some bacterial species or consortia are able to synthesize butyrate from propionate. This is also sustained by numerations which never evidenced high numbers of acetate-fermenting butyrogens (less than 1000,000 cells/ml) and by the dismutation of propionate in the presence of bromo ethane sulfonic acid. But metabolic pathways remain unclear. In fact, acetate and butyrate may originate from a single four-carbon intermediate or butyrate may be synthesized from acetyl-CoA as in Clostridia. Complete acetogenesis from propionate in some digesters proceeds not only through an oxidative decarboxylation but also through Beta-oxidation of butyrate by organisms similar to Syntrophomonas wolfei. (See also W90-03850) (Author's abstract)
W90-03864

EFFECTS OF THE ADDITION OF PROPIONATE AND BUTYRATE TO THERMOPHILIC METHANE-PRODUCING DIGESTERS.

Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
For primary bibliographic entry see Field 5E.
W90-03865

COMBINED METABOLISM OF BUTYRIC ACID AND WASTE ACTIVATED SLUDGE AT THERMOPHILIC TEMPERATURES.
Kansas Univ., Lawrence. Dept. of Chemical and Petroleum Engineering.
R. E. McKinney, and R. Shamskorzani.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 247-260. 5 fig, 10 ref.

Descriptors: *Wastewater treatment, *Butyric acid, *Activated sludge process, *Anaerobic digestion, *Sludge digestion, *Retention time, Methane bacteria, Chemical oxygen demand, Temperature, Loading.

A laboratory study was carried out using a 1.5 liter, fixed media anaerobic reactor with intermittent mixing and once daily feeding of Lawrence, Kansas, WWTP waste activated sludge and butyric acid. The research was divided into three phases. Phase 1 was a study of decreasing the hydraulic retention time from 10 days to 2 days while keeping the temperature constant at 50 degrees C and the butyric acid COD constant at 3 g/d. Once good operations were established at 2 days retention, the butyric acid COD was increased to 18 g/d at a constant waste activated sludge loading. The digester became saturated with solids at 6 g/d COD and remained saturated for the remainder of the study. The system became overloaded when the total BCOD fed rose from 13.7 g/d to 16.7 g/d. The third phase consisted of feeding waste activated sludge only and increasing the temperature from 50 degrees C to 70 degrees C. Good operations occurred at 50 degrees C, 55 degrees C and 60 degrees C. The methane bacteria began to be adversely affected as the temperature increased. These results indicated that the biodegradable fraction of waste activated sludge was 92% metabolized with 3 days hydraulic retention and 11 days solids retention time at 50 degrees C. The fixed media system gave good anaerobic digestion of both the waste activated sludge and the soluble butyric acid even when the system was saturated with solids. (See also W90-03850) (Author's abstract)
W90-03866

ANAEROBIC DIGESTION OF HEMICELLULOSIC FEEDSTOCKS.
Solar Energy Research Inst., Golden, CO. Solar Fuels Div.
C. Rivard, M. Himmel, and K. Grohmann.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 261-282. 6 fig, 3 tab, 19 ref.

Descriptors: *Anaerobic digestion, *Microbial digestion, *Cellulose, *Wastewater treatment, *Farm wastes, Methane, Acid, Pretreatment.

Lignocellulosic biomass in its native form is highly resistant to microbial attack. Exceedingly long reaction times (10-90 days) are required for complete microbial conversion of even the more degradable feedstocks such as straw, corn stover and municipal solid wastes (MSW) to methane. Controlled acid pretreatment of these feedstocks, besides enhancing the digestibility of the cellulosic residue, liberates soluble hemicellulosic polymers which are further degraded to free sugars by enzymatic hydrolysis within the anaerobic digestion system and ultimately converted to biogas. Pretreatment hydrolysate liquor expressed from straw (a model low value biomass feedstock) cooked at 120 degrees C with dilute phosphoric acid was successfully used as feed in a mesophilic anaerobic digestion system. Stirred and packed bed anaerobic reactors were examined as systems for the conversion of biomass hydrolysate liquor to methane. Various column packing materials for packed bed reactors were also evaluated. After maturation of microbial attachment to the bed material, preliminary rates of 3.5 volumes of biogas (65% methane) per reactor volume per day were attained in the packed bed reactors. The effect on digestor performance of trace quantities of several compounds present in acid hydrolysates of biomass, such as furfural, 5-hydroxymethyl furfural, low molecular weight lignin and lignin precursors, was also investigated. (See also W90-03850) (Author's abstract)
W90-03867

GASIFICATION OF CONCENTRATED PARTICULATE AND SOLID SUBSTRATES BY BIPHASIC ANAEROBIC DIGESTION.
Institute of Gas Technology, Chicago, IL.
S. Ghosh.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 303-320. 4 fig, 3 tab, 5 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Farm wastes, *Anaerobic digestion, *Microbial degradation, *Methane, Hydraulic retention time, Efficiency, Organic matter.

The development and performances of two innovative configuration of the two-phase anaerobic digestion process for gasification of concentrated organic slurries and high-solids feeds are analyzed. The data show that the conventional single-stage digestion process is unsuitable for application to high-solids-content and concentrated feeds, and that efficient and rapid-rate gasification of these feeds can be better achieved by separated acidogenic and methanogenic fermentations. A process configuration utilizing upflow acid-phase and methane-phase digesters was demonstrated to be considerably superior to the conventional single-stage digestion process in terms of methane yield and production rate and net energy production. This process afforded a methane yield of 0.48 SCM/kg VS added (7.7 SCF/lb VS added) for a sewage sludge feed at a hydraulic residence time of 5.9 days; this performance was better than those reported in the literature for this type of feed. For low-moisture feeds such as MSW, a downflow leach-bed acid-phase fermenter was utilized to liquefy an organic bed of solids to generate a high volatile acids-content bioleachate product, which was sequentially gasified in a separate upflow methane digester. This system, operated under ambient conditions, provided for recycling of the indigenous nutrients, and did not require the addition of any external water; it afforded a methane yield which was 80% of the theoretical value. (See also W90-03850) (Author's abstract)
W90-03868

PRELIMINARY EVALUATION OF THE EFFECTS OF A D-RDF BINDING AGENT, RDF PARTICLE SIZE AND HEAT PRETREATMENT ON EFFICIENCY OF ANAEROBIC DIGESTION OF RDF.
Cyclic Energies, Inc., Denton, TX.
V. K. Wright, B. J. Venables, and K. E. Daugherty.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 343-354. 3 tab, 19 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Waste recovery, *Fuel, *Food-processing wastes, Particle size, Refuse derived fuel, Pilot studies, Heat, Calcium oxide.

A version of an upflow anaerobic sludge blanket (UASB) digester for conversion of biodegradable organics to a high Btu biogas is being evaluated at the pilot plant scale at the City of Denton municipal sewage treatment plant. The digester design under study was originally developed, tested and commercially used for stabilization of food-processing wastes. Hydraulic retention time of 24 hours resulted in a 55% reduction in COD and 95% reduction in suspended solids. In concert with the development of binder systems for densified-refuse derived fuel (d-RDF), under a Department of Energy/Argonne National Laboratory grant, binding agents and other factors affecting efficiency of anaerobic digestion of potential d-RDF products are being evaluated. Laboratory scale anaerobic digesters demonstrated no effects using two commercially available particle sizes of RDF or the presence of calcium oxide, a potential d-RDF binder, on digestion efficiency. Efficiency was significantly increased by a heated pretreatment. (See also W90-03850) (Author's abstract)
W90-03869

NEW CONCEPT FOR THE PRODUCTION OF HIGH-BTU GAS FROM ANAEROBIC DIGESTION.
Gas Research Inst., Chicago, IL.
For primary bibliographic entry see Field 5E.
W90-03870

BIOCONVERSION OF MUNICIPAL SOLID WASTE AND SEWAGE SLUDGE TO ETHANOL.
Southern Research Inst., Birmingham, AL.
For primary bibliographic entry see Field 5E.
W90-03871

STOCHASTIC DESIGN OF WASTEWATER STORAGE FOR LAND APPLICATION.
Texas Univ., Austin. Center for Research in Water Resources.
K. A. Al-Omari, S. G. Buchberger, and D. R. Maidment.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-236269/AS, price codes: A07 in paper copy, A01 in microfiche. Final Report, April 1989. 134p, 41 fig, 20 tab, 38 ref, 3 append. USGS Contract no. 14-08-0001-G1318.

Descriptors: *Wastewater treatment, *Land disposal, *Design criteria, *Wastewater lagoons, *Stochastic process, Wastewater irrigation, Reservoir modeling, Markov process, Probabilistic process, Storage reservoirs, Reliability, Risk assessment.

This report presents an application of a probabilistic design method, based on the theory of Markov diffusion processes, to estimate the reliability of a wastewater storage pond subject to random inflows and outflows. Reliability is defined as the steady-state probability that wastewater will not enroach on a designated freeboard zone. The design method involves sizing a wastewater storage facility to meet a prescribed reliability criterion. Sizing includes computing the pond surface area, embankment height and storage capacity. The application involves a case study of the Hancock Farm near Lubbock, Texas, where slow rate irrigation has been used since 1982 to treat municipal wastewater. Relevant data collected are monthly wastewater inflow, seepage, precipitation, evaporation and hydraulic loading rates for the period April 1982 to December 1987. The effect of the field to pond area ratio on facility performance was investigated. Results show when the pond is more efficient than the field for wastewater disposal, reducing the field to pond area ratio will maximize the total release rate and thus will minimize the total area requirement. Conversely, when the field is more efficient, increasing the field to pond area ratio will maximize the total release rate and thus will minimize the total area requirement for a land treatment system. (USGS)
W90-03892

SOIL PHASE PHOTODEGRADATION OF TOXIC ORGANICS AT CONTAMINATED DISPOSAL SITES FOR SOIL RENOVATION AND GROUNDWATER QUALITY PROTECTION.
Utah Water Research Lab., Logan.
W. Moore, R. R. Dupont, and J. E. McLean.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-237267/AS, price codes: A07 in paper copy, A01 in microfiche. Final Report, August 1989. 115p, 22 fig, 35 tab, 97 ref, append. USGS Contract no. 14-08-001-G1304.

Descriptors: *Groundwater quality, *Water quality control, *Hazardous wastes, *Photodegrada-

tion, *Soil contamination, *Wood preserving wastes, *Decontamination, Organic compounds, Toxic substances, Waste disposal.

Accurate assessment of the potential for contaminated soil remediation requires detailed knowledge of the fate of waste constituents within the soil environment. For many non-biodegradable organics compounds, photochemical degradation may provide a potential pathway for the removal of such compounds from soil surfaces. A study was conducted to evaluate the rate of photodegradation of ten hazardous organic compounds from three soils, silica gel, and four soil minerals (kaolinite, montmorillonite, illite, and calcite) under conditions of controlled irradiation. In addition, the effect of six amendment treatments (methylene blue, riboflavin, hydrogen peroxide, diethylamine, peat moss, and silica gel) on the rates of compound loss was also investigated. Soil and mineral samples were spiked with various combinations of m-cresol, quinoline, biphenyl, dibenzo(a)furan, fluorene, pentachlorophenol, phenanthrene, anthracene, 9H-carbazole and pyrene at either 500 or 1000 mg/kg initial soil concentration of each chemical. Amendments were applied to the soils and minerals and samples were irradiated under ultraviolet or visible light while spiked controls were incubated in the dark. Linear regression of soil/mineral contaminant concentration data showed that first order kinetic modeling best described the degradation process. Significant loss of anthracene occurred on all surfaces tested although the rate of loss varied with surface type and, for some surfaces with the spiking solution concentration and chemical mixtures. Anthracene loss from silica gel was the most rapid of all reactions observed. Skumpah soil, a light colored alkaline soil, yielded the greatest reduction in contaminant concentrations found in the soil studies. Calcium kaolinite displayed the most rapid kinetics of the mineral surfaces tested. Loss of the other test compounds was observed from only some of the surfaces investigated. Anthraquinone and fluorenone were identified as the major degradation products of the photoreaction of anthracene and fluorene. Under the conditions of this study, soil and mineral type, as well as surface renewal via mixing, had more effect on degradation rates than any of the amendments that were tested. (Dupont-UWRL,USU)
W90-03893

RESEARCH ON THE HEALTH IMPLICATIONS OF THE USE OF RECYCLED WATER IN SOUTH AFRICA.
Water Research Commission, Pretoria (South Africa).
For primary bibliographic entry see Field 3C.
W90-03925

VIROLOGICAL STUDIES OF WATER FROM THE CAPE FLATS RECLAMATION PLANT.
Cape Town Univ. (South Africa). Dept. of Medical Microbiology.
For primary bibliographic entry see Field 5A.
W90-03926

CSO PARTNERSHIP: CITIES JOIN FORCES ON COMBINED SEWERS.
Greeley and Hansen, Camp Springs, MD.
For primary bibliographic entry see Field 5E.
W90-03954

FUNDING WASTEWATER PROJECTS WITH IMPACT FEES.
Camp, Dresser and McKee, Inc., Edison, NJ.
For primary bibliographic entry see Field 6C.
W90-03955

BACTERIA IN THE AEROBIC BIODEGRADATION OF WOOL SCOURING EFFLUENT.
Durban-Westville Univ. (South Africa). Dept. of Microbiology.
G. Roth, R. A. Oellermann, and B Odhav.
Water SA WASADV, Vol. 15, No. 4, p 209-220, October 1989. 6 fig, 2 tab, 29 ref.

Descriptors: *Wool scouring, *Bacteria, *Biodegradation, *Biological wastewater treatment, *Wastewater treatment, Chemical oxygen demand, Surfactants, Effluents, Algae, Flocculation, Clarification.

The bacterial flora in the aerobic biodegradation of wool scouring effluent was studied. Phase I of the biodegradation of the effluent, which was carried out in the absence of algae and sunlight, extended over a period of 16 wk, and Phase II in the presence of algae and sunlight extended over a period of 9 wk. Partial clarification occurred during Phase I as indicated by the reduction in chemical oxygen demand (COD), surfactant breakdown, and lighter color. Flocculation occurred during the period of 8-12 wk and a steady state developed after 14 wk. Although algae largely contributed to the clarification during Phase II, the bacterial population also showed a changes resulting in relatively clear water. Bacteria were isolated at fortnightly intervals during the entire experimental period and their general characteristics described. The total viable counts increased from 80,000/ml to more than 800,000,000/ml after 16 wk. The slight apparent reduction in numbers between 8 and 10 wk could be explained by floc formation resulting in aggregates being counted as single cells. COD was determined during Phase I. After 14 wk it was reduced by 72% of the initial value of approximately 6,000 mg/l. Surfactant was degraded rapidly from approximately 60 microliter/5-ml sample after 6 wk, with practically no further detectable breakdown up to 16 wk. Biodegradation and clarification of the wool scouring effluent was achieved in this laboratory-simulated natural ecosystem. (Author's abstract)
W90-03989

ANAEROBIC TREATMENT OF INDUSTRIAL EFFLUENTS IN SOUTH AFRICA.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
W. R. Ross.
Water SA WASADV, Vol. 15, No. 4, p 231-246, October 1989. 7 fig, 9 tab, 20 ref.

Descriptors: *Food-processing wastes, *South Africa, *Biological wastewater treatment, *Industrial wastes, *Biodegradation, *Wastewater treatment, Biogas, Energy, Farm wastes, Industrial wastes, Process control, Activated sludge, Performance evaluation.

Biodegradable industrial effluents generally are best treated by anaerobic digestion. The main advantages of the anaerobic process are higher load rates and degree of purification, lower energy costs due to biogas production, and lower surplus sludge production compared to aerobic treatment. The successful operation is described of various full-scale plants in South Africa for the treatment of maize-processing (Bellville sewage works and African products, Meyerton), wine distillery (Paarl sewage works and Stellenbosch sewage works), abattoir (Cato ridge abattoir), brewery (SA Breweries, Prospecton), and apple-processing wastes (Ceres Fruit Growers, Ceres, and Appletiser Pure Fruit Juices, Grabouw). With essentially biodegradable wastes, a 80-97% degree of purification is attained. Effluents deficient in the major nutrients N and P and in buffer requirements can be supplemented by chemical addition. The concentration and pH of the waste may vary substantially over a short period and it has been found useful to provide balancing capability. In South Africa both upflow sludge blanket and contract-type plants have been in general use. These plants rely on clarifiers to concentrate and recycle the biomass to the digestion compartment. Experience indicates that no single parameter is sufficiently sensitive to permit reliable forecasting of incipient overload or digester failure, particularly at high load rates. Effective monitoring requires a combination of physical, chemical, and biological indices. The most useful control parameters to ensure process stability and reliability are: maintaining digester pH between 6.8 and 7.2 with bicarbonate alkalinity in excess of 1500 mg/l; maintaining the sludge load rate below 0.5 kg COD volatile suspended solids/day at 35 C; and controlling the feed rate to ensure that 0.5 cu m of biogas is generated per kg of COD used. (Rochester-PTT)
W90-03992

UNRELIABILITY OF COLD-STORED SAMPLES FOR ASSESSMENT OF CHEMICAL PRECIPITATES OF PHOSPHATE IN ACTIVATED SLUDGE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
D. W. de Haas, and I. A. Dubery.
Water SA WASADV, Vol. 15, No. 4, p 257-260, October 1989. 2 tab, 15 ref.

Descriptors: *Wastewater treatment, *Sludge analysis, *Phosphates, *Errors, *Activated sludge, *Chemical analysis, Performance evaluation, Precipitates, Cold storage, Freezing.

The effect of orthophosphate and polyphosphate levels was investigated in refrigerated or frozen activated sludge samples. A short fractionation procedure was used involving removal of the supernatant, washing with physiological saline, and extraction at 0 C with perchloric acid. Storage at 4 C or -20 C (followed by thawing at 15 C or room temperature) resulted in polyphosphate hydrolysis to orthophosphate. The orthophosphate may have been interpreted erroneously in the past as a 'chemical precipitate.' It may be concluded that analysis of orthophosphate and polyphosphate in activated sludge probably are suspect unless conducted immediately after sampling. Marked overestimation of chemical precipitate is likely where 'dewatered' sludge samples have been stored in refrigerators or freezers for periods of days or months. (Rochester-PTT)
W90-03995

USE OF THE ANALYTICAL PROFILE INDEX IN THE IDENTIFICATION OF ACTIVATED SLUDGE BACTERIA: PROBLEMS AND SOLUTIONS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
S. N. Venter, L. H. Lotter, D. W. de Haas, and L. MacDonald.
Water SA WASADV, Vol. 15, No. 4, p 265-267, October 1989. 2 tab, 16 ref.

Descriptors: *Sludge analysis, *Activated sludge, *Bacteria, *Bacterial analysis, Analytical profile index, Acinetobacter, Errors.

The accuracy of activated sludge isolate identification by the analytical profile index (API) 20E system was evaluated relative to conventional biochemical tests. The API test gives reliable identification provided inoculi are in the logarithmic growth phase, fermentations are checked 24 hr after the first reading, and a standard oxidase test is performed as a control to that of the API system. Failure to take such precautions may give inappropriately high Acinetobacter counts for activated sludge. (Author's abstract)
W90-03997

USE OF AQUATIC MACROPHYTES IN WATER-POLLUTION CONTROL.
Aarhus Univ. (Denmark). Botanical Inst.
H. Brix, and H. H. Schierup.
AMBIO AMBOCX, Vol. 18, No. 2, p 100-107, 1989. 4 fig, 35 ref.

Descriptors: *Wastewater treatment, *Macrophytes, *Water pollution treatment, *Aquatic plants, *Biological wastewater treatment, *Water treatment facilities, Reclaimed water, Water quality control, Floating plants, Submerged plants, Wetlands, Water pollution control, Denmark.

Ecosystems dominated by aquatic macrophytes are among the most productive in the world. Aquatic plants possess an outstanding ability for assimilating nutrients and crating favorable conditions for microbial decomposition of organic matter. This ability can be exploited in the restoration process of natural streams, lakes and wetlands, and in wastewater-treatment systems. Four different types of macrophyte-based wastewater-treatment facilities are discussed. Floating macrophyte treatment

systems use plants not rooted in the substrate. Of these, water hyacinth and duckweed appear most promising. Water hyacinth has been used successfully in the tropics and subtropics, however it is not cold resistant therefore limiting their use in temperate regions. Duckweed is used mainly for recovering nutrients and can provide animal fodder. It is subject to wind damage, however. Submerged macrophyte treatment systems require oxygenated water thereby limiting their use in 'polishing' of secondarily treated wastewaters. It is still in the experimental stage with species like egeria, elodea, hornwort, and hydrilla being the most promising. Emergent macrophyte treatment systems (artificial and natural wetlands) have large internal air spaces for transportation of oxygen to roots and rhizomes. In 1983 a macrophyte-based system named the Root-Zone method was introduced in Denmark. It depends on the sub-surface flow of water through the rhizosphere using the common reed (Phragmites australis). This allows microbial decomposition, dinitrification, as well as soil fixation of nitrogen and heavy metals. In addition the reeds supply oxygen to the heterotrophic microorganisms while increasing and stabilizing the hydraulic conductivity of the soil. The Root-Zone method costs between 10- 50% of convention technology. Integrated macrophyte treatment systems involves combination of the above described systems with each other or with conventional technology. The potential for resource recovery by harvesting and utilization of the plant material produced can be regarded as a step in the direction of a holistic solution where waste products will be regarded and utilized as a resource. (Author's abstract)
W90-04003

DYNAMIC PARTICLE ADHESION PROCESS AND ITS EFFECT ON PARTICLE AGGREGATION.
Rheinisch-Westfaelische Wasserwerksgesellschaft m.b.H., Muelheim an der Ruhr (Germany, F.R.). Inst. fuer Wasserchemie und Wassertechnologie.
For primary bibliographic entry see Field 2K.
W90-04013

EXPERIENCES WITH GROUNDWATER TREATMENT AND DISPOSAL OF THE ELIMINATED SUBSTANCES IN THE NETHERLANDS.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 5F.
W90-04018

DEGRADATION OF CHLORINATED ALIPHATIC HYDROCARBONS BY METHYLOSINUS TRICHOSPORIUM OB3B EXPRESSING SOLUBLE METHANE MONOOXYGENASE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Biochemistry.
R. Oldenhuis, R. L. J. M. Vink, D. B. Janssen, and B. Witholt.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2819-2826, November 1989. 3 fig, 3 tab, 23 ref.

Descriptors: *Wastewater treatment, *Biodegradation, *Microbial degradation, *Chlorinated hydrocarbons, *Methane, *Aquatic bacteria, Fate of pollutants, Copper, Kinetics, Chlorides.

Degradation of trichloroethylene (TCE) by the methanotrophic bacterium Methylosinus trichosporium OB3b was studied by using cells grown in continuous culture. TCE degradation was a strictly cometabolic process, requiring the presence of a cosubstrate, preferably formate, and oxygen. M. trichosporium OB3b cells degraded TCE only when grown under copper limitation and when the soluble methane monooxygenase was derepressed. During TCE degradation, nearly total dechlorination occurred, as indicated by the production of inorganic chloride, and only traces of 2,2,2-trichloroethanol and trichloroacetaldehyde were produced. TCE degradation proceeded according to first-order kinetics from 0.1 to 0.0002 mM TCE with a rate constant of 2.15 ml/min/mg of cells. TCE concentrations above 0.2 mM inhibited degradation in cell suspensions of 0.42 mg of cells/ml. Other chlorinated aliphatics were also degraded by M. trichosporium OB3b. Dichloromethane, chloroform, 1,1-dichloroethane,and 1,2-dichloroethane were completely degraded, with the release of stoichiometric amounts of chloride. trans-1,2,-Dichloroethylene, cis-1,2-dichloroethylene, and 1,2-dichloropropane were completely converted, but not all the chloride was released because of the formation of chlorinated intermediates, e.g., trans-2,3-dichlorooxirane, cis-2,3-dichlorooxirane, and 2,3-dichloropropanol, respectively. 1,1,1-Trichloroethane, 1,1-dichloroethylene, and 1,3-dichloropropylene were incompletely converted, and the trichloroethane yielded 2,2,2-trichloroethanol as a chlorinated intermediate. The two perchlorinated compounds tested, carbon tetrachloride and tetrachloroethylene, were not converted. (Author's abstract)
W90-04030

FIBER-OPTIC DIPPING SENSOR FOR ORGANIC SOLVENTS IN WASTEWATER.
Erlangen-Nuernberg Univ., Erlangen (Germany, F.R.). Inst. fuer Physikalische und Theoretische Chemie.
For primary bibliographic entry see Field 7B.
W90-04036

HOLLOW FIBER MEMBRANE PROBES FOR THE IN SITU MASS SPECTROMETRIC MONITORING OF NITROGEN TRICHLORIDE FORMATION DURING WASTEWATER TREATMENT.
Dow Chemical Co., Midland, MI. Analytical Sciences.
P. J. Savickas, M. A. LaPack, and J. C. Tou.
Analytical Chemistry ANCHAM, Vol. 61, No. 20, p 2332-2336, October 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Water analysis, *Wastewater analysis, *Wastewater treatment, *Pollutant identification, *Mass spectrometry, *Chlorides, Monitoring, Ammonia, Nitrogen compounds, Membranes, Industrial wastewater, Chemical wastewater.

The utility of a hollow fiber membrane probe interface in the monitoring of potential NCl3 (nitrogen trichloride) formation during bleach chlorinolysis treatment of chemical waste streams containing ammonia or other nitrogen-containing species was examined. With the hollow fiber probes, factors such as the membrane material's area, thickness, and temperature could be varied to find suitable characteristics. The probe was tested in both batch and continuous chlorination experiments. A cross-linked silicone polymer hollow fiber probe was tried in a double-loop design. A second non-cross-linked probe was fashioned to sample the relatively low concentration sample region at the vent of the reflux condenser. Preliminary experiments, accomplished by injecting small amounts of chlorinated organics into the reactor vessel, showed system response time to be about 5-10 sec and with part per million (ppm) sensitivities. Continuous feed experiments in which 0.5% ammonia solution was continuously fed into the reactor along with bleach solution showed no build up of NCl3 such as was found in the batch mode of operation. Experiments using synthetic waste containing 500-1000 ppm total organic carbon (TOC) mostly nitrogen-containing species showed a build-up of NCl3 in the batch operation at a point when the oxidation reaction is essentially complete, but no NCl3 formation when the continuous mode was used. NCl3 concentration in the reactor rose with a decrease in temperature, probably due to a complex change in the solubilities of key intermediates in the NCl3 formation. (Geiger-PTT)
W90-04038

PHOTOCATALYTIC DEGRADATION OF NONYLPHENOL ETHOXYLATED SURFACTANTS.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
For primary bibliographic entry see Field 5B.
W90-04048

FRACTAL GEOMETRY OF PARTICLE AGGREGATES GENERATED IN WATER AND WASTEWATER TREATMENT PROCESSES.
Toronto Univ. (Ontario). Dept. of Civil Engineering.
D. Li, and J. Ganczarczyk.
Environmental Science and Technology ESTHAG, Vol. 23, No. 11, p 1385-1389, November 1989. 5 fig, 2 tab, 24 ref.

Descriptors: *Particle shape, *Particulate matter, *Water treatment, *Fractal geometry, *Wastewater treatment, Computer models, Mathematical studies, Aggregates, Trickling filters, Activated sludge, Particle size, Flocculation.

A fractal is a mathematical description of highly irregular geometric shapes. Particle aggregates generated in water and wastewater treatment processes possess fractal features. The fractal dimension for the structure of the aggregates determined in this work (activated sludge flocs, alum aggregates, clay-magnesium flocs, clay-iron flocs, particles in trickling filter effluent, and ferric aggregates) ranged from 1.4 to 2.8. The fractal nature of the aggregates was also observed in computer-simulated models. The concept of the fractal dimension can be applied in water and wastewater treatment in the characterization of the aggregates geometry, in substrate transfer to biological aggregates, and in the process of aggregation or flocculation. (Geiger-PTT)
W90-04049

DEWATERING CHARACTERISTICS OF ACTIVATED SLUDGES AND EFFECT OF EXTRACELLULAR POLYMER.
Osaka Univ. (Japan). Faculty of Engineering.
S. M. Kang, M. Kishimoto, S. Shioya, T. Yoshida, and K. I. Suga.
Journal of Fermentation and Bioengineering JFBIEX, Vol. 68, No. 2, p 117-122, August 1989. 9 fig, 2 tab, 22 ref.

Descriptors: *Dewatering, *Activated sludge, *Wastewater treatment, *Filtration, *Sludge disposal, *Sludge drying, Permeability, Porosity, Mathematical studies, Polymers, Separation techniques.

Shirato's expression theory, which is based on Ruth's filtration theory and Terzaghi's consolidation theory, was applied to an analysis of the dewatering characteristics in activated sludges. The dewatering characteristics of the sludges were analyzed during the filtration and consolidation periods; the effects of extracellular polymer on the dewatering process was also studied. It was confirmed that Ruth's average specific resistance was increased and Shirato's modified consolidation coefficient decreased by adding the extracellular polymer substance extracted from the sludges. The extracellular polymer was found to have a bad effect on the dewatering process through the two periods. From the results of compression-permeability testing, the addition of extracellular polymer did not affect the local porosity, but it did have a great influence on the local specific filtration resistance. (Geiger-PTT)
W90-04057

CASE HISTORIES OF STARTUP AND OPERATION OF THE ENVIREX ORBAL AERATION PROCESS.
PSC Engineers and Consultants, Inc., Reading, PA. Environmental Div.
L. E. Ritter.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 6, p 7-13, November 12, 1989. 2 fig, 4 tab, 4 ref.

Descriptors: *Wastewater treatment, *Aeration, *Chemical treatment, *Aerobic digestion, Pennsylvania, Phosphorus, Biological oxygen demand.

Three treatment plants that employ Orbal aeration differently were compared. In Ephrata, Pennsylvania, the main function of the Orbal process was nitrification of NH3-N and removal of most of the remaining biological oxygen demand from 3.8

MGD of wastewater that had previously received preliminary treatment. Phosphorus removal, in addition to biological removal, was by chemical precipitation. The Orbal system at the Chalfont-New Britain plant was designed to treat 4.0 MGD of wastewater. At Troy, PA, the only usable existing facility was an aerobic digestion tank. There, 0.222 MGD of preliminary treated wastewater that received grinding and grit removal was pumped directly to the Orbal system. All three plants produced excellent quality effluents. The Orbal system used in different applications showed that it was versatile, efficient, and met all the manufacturer's claims for removal of biological oxygen demand, suspended solids, nitrogen, and phosphorus. The storm flow pattern proved an outstanding feature of the Orbal system. The system could be used effectively with circular clarifiers or rectangular settling tanks designed to like parameters. The Orbal also produced a high quality effluent and a large quantity of excess sludge compared to what might be expected under conditions of extended aeration loading. (Mertz-PTT)
W90-04068

SUITABILITY OF ION EXCHANGE RESINS FOR THE REMOVAL OF CADMIUM FROM WASTEWATERS. PART III: EFFECT OF ADSORBENT DOSE.
Villanova Univ., PA. Dept. of Chemical Engineering.
V. L. Punzi, and M. R. Stober.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 6, p 18-21, November 12, 1989. 3 tab, 3 ref.

Descriptors: *Cadmium, *Adsorbents, *Wastewater treatment, *Resins, Chemical treatment, Ion exchange, Hydrogen ion concentration.

Cadmium adsorption was studied as a function of wastewater pH and adsorbent dose for four different adsorbents; adsorbents used included IRC-718, Nuchar SN, 252, and IR-120PD. Results obtained using adsorbent doses that were significantly lower than those used in earlier studies confirmed the superiority of Rohm and Haas IRC-718 for use in the industrial waste treatment applications simulated. In each of the the 60 experiments, aqueous cadmium chloride solutions initially containing 10 mg Cd(II)/L were used as the synthetic waste. Adsorption studies were performed at 25 C by adding a known mass of adsorbent to 500 mL of synthetic waste. The adsorbent dose was varied as a function of both adsorbent and pH, with actual dose chosen to produce final Cd(II) concentrations between 0.01 and 5.0 mg/L. The long-term cadmium removal efficiency increased monotonically as adsorbent dose increased for all adsorbents at all pHs tested. Except for unexplainable results observed at a pH of 5 for low adsorbent doses of Nuchar SN, it appeared that a dose existed at which a long-term removal efficiency of nearly 100% Cd(II) removal could occur. In comparing the performance of the resins, the cadmium removal achieved after 20 min and after 1 hour generally increased monotonically as adsorbent dose increased, for resins tested at pHs of 3, 5 and 7. (Mertz-PTT)
W90-04069

ODOR CONTROL IN PUMPING STATIONS AND COLLECTION SYSTEMS.
Coyne (George S.) Chemical Co., Inc., Croydon, PA. Environmental Services Group.
D. J. Maugle.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 6, p 23-30, November 12, 1989. 11 tab.

Descriptors: *Odor control, *Hydrogen sulfide, *Wastewater treatment, *Chemical treatment, Chlorine, Potassium compounds, Sulfates, Activated carbon, Hydrogen peroxide.

Most of the odors associated with the transference of sewage to the treatment plant are of a sulfide nature, with the main offender being hydrogen sulfide. This compound can be found in two forms: insoluble sulfides and dissolved sulfide. The dissolved fraction is the culprit causing odor complaints and destruction. Various chemicals have been found to reduce levels of hydrogen sulfide in sanitary sewer systems. These include activated carbon scrubbers, alkalinity control, chlorine, ferrous chloride, ferrous sulfate, hydrogen peroxide, potassium permanganate, and sodium hypochlorite scrubbing. Hydrogen peroxide is easy to apply, reacts preferentially with H2S and has no harmful side effects from overdosing. Chlorine reacts rapidly, oxidizes other odorous compounds (such as ammonia) and is available in several forms. Potassium permanganate quickly reacts, oxidizes other odorous compounds, works well in high solid waste streams and removes grease build-up in lines and wet wells. Ferrous sulfate is easy to handle, reacts relatively quickly, removes phosphorous and has a low cost. Ferrous chloride has benefits similar to ferrous sulfate; it can also be used in long detention lines. Sodium hypochlorite/carbon scrubbers are very efficient and oxidize or adsorb many odorous compounds. Each of the products carry their own disadvantages and costs may vary considerably. (Mertz-PTT)
W90-04070

ALGAE OCCURRING IN AN UNCOVERED TRICKLING FILTER OF A SEWAGE TREATMENT PLANT IN CRACOW.
Polish Academy of Sciences, Krakow. Inst. of Botany.
K. Wolowski.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 82, No. 2, p 207-239, August 1989. 38 fig, 5 tab, 71 ref.

Descriptors: *Wastewater treatment, *Trickling filters, *Algal growth, *Biological wastewater treatment, Poland, Nuisance algae, Stigeoclonium, Hyponomonas, Chlorella, Sphaerotilus, Zoogloea, Fusarium, Fungi.

The sparsity of information in the world literature provided the incentive to investigate and characterize the algae present in the trickling filter of the Kliny housing estate in Cracow, Poland. The presence of green algae, diatoms, and blue-green algae, in addition to the numerous bacteria, sewage fungi, and other organisms in the periphyta covering the surface of trickling filters, is a normal phenomenon in open-air sewage treatment plants. The presence of algae on the surface of filters is welcome, since they utilize simple chemical compounds resulting from the activity of sewage bacteria and fungi, directly on the filter surfaces, and also provide additional quantities of oxygen to be utilized in the biodegradation of the sewage. They pose no threat to the efficiency of the filter, provided their development is controlled. Samples were taken from stones lying on the surface of the filter bed. In 1979 and 1980 samples were taken at monthly intervals, but in 1981 only five times. The mass occurrence of some species coupled with the simultaneous recession of others caused the surface of the filter to change color. A green aspect with Stigeoclonium tenue, Hyponomonas chlorococcides, and Chlorella vulgaris indicated that the filter was functioning properly. A grey-green one, caused by the development of large quantities of the bacteria Sphaerotilus natans and Zoogloea ramigera on the dying algae indicated aging of the periphytic algae and that the filter was not working well. An orange color, with the dominating fungus Fusarium aquaeductum, demonstrated decay of the periphyton, and poor functioning of the filter. (Mertz-PTT)
W90-04072

ANAEROBIC TREATMENT OF BREWERY EFFLUENT.
Hong Kong Univ. Dept. of Civil Engineering.
H. H. P. Fang, Z. Jinfu, and L. Guohua.
Biotechnology Letters BILED3, Vol. 11, No. 9, p 673-678, September 1989. 3 fig, 7 ref.

Descriptors: Biological wastewater treatment, *Anaerobic digestion, *Effluents, *Wastewater treatment, Chemical oxygen demand, Biological oxygen demand, Sludge seeding, Brewery wastes.

Brewery effluent with high organic content was treated anaerobically in a 1.17 cubic meter reactor over five months. The reactor was first seeded with a mixture of sludges: about half of the sludge was from an anaerobic digester of a secondary treatment plant and the other half was collected from the sludge of a local pond and sieved through a fine screen. The volatile suspended solids/total suspended solids ratio of the sludge was 0.24, initially. It was steadily improved to 0.40 in two months, and reached 0.43 at the end of the experiment. At 26 C, and with a hydraulic retention time of 13.3 hours and a loading rate of 4.6 kg chemical oxygen demand/cubic meter/day, the process reduced over 89% of chemical oxygen demand and 92% of biochemical oxygen demand from the brewery effluent. Both reductions could be further improved by more effective removal of suspended solids. (Mertz-PTT)
W90-04087

VEGETATIVE FILTER TREATMENT OF DAIRY MILKHOUSE WASTEWATER.
Vermont Dept. of Environmental Conservation, Waterbury.
C. B. Schwer, and J. C. Clausen.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 446-451, October-December 1989. 4 fig, 3 tab, 22 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Dairy industry, *Phosphorus, *Nitrogen, Animal wastes, Hydraulic loading.

A vegetated filter strip constructed to treat milkhouse wastewater from a Vermont dairy farm was evaluated to determine its effectiveness in reducing solids, P and N concentrations and exports in surface and subsurface flow. The liquid waste was applied twice daily via a level lip spreader at a rate of 2.94 cm/wk on a vegetated loam soil having a 2% slope. The flow and concentrations of inputs and surface and subsurface outputs were continuously monitored during the 2-yr study. The strip significantly reduced solids, P, and N on a concentration basis, and retained 95% solids, 89% P, and 92% N on a mass basis. Retention was the greatest during the growing season and the poorest during snowmelt periods. Concentrations in subsurface outputs were greater than in surface runoff and more than 75% of the mass export was in subsurface flow. Comparisons of this study with values reported in the literature suggests that hydraulic loading rate governs the effectiveness of filter strip treatment. (Author's abstract)
W90-04102

INFILTRATION OF WASTEWATER IN A NEWLY STARTED PILOT SAND-FILTER SYSTEM: I. REDUCTION OF ORGANIC MATTER AND PHOSPHORUS.
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
M. Pell, and F. Nyberg.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 451-457, October-December 1989. 6 fig, 5 tab, 26 ref.

Descriptors: *Wastewater treatment, *Phosphorus, *Organic matter, *Sand filters, Sweden, Chemical oxygen demand, Septic tanks, Filtration, Pilot plants.

The objective of the study was to monitor variables on P and organic matter reduction related to the wastewater purification process in a sand-filter system constructed according to the directives issued by the National Swedish Environment Protection Board. Monitoring was conducted from start-up until a steady state was reached. The system consisted of a three-chambered septic tank, a pilot sand-filter, corresponding to the demand for one person, and eight sand-filter columns. It was loaded with 67 L/sq m/d of an artificial wastewater. The effluent from the septic tank reached a steady state with respect to the chemical oxygen demand and P levels after 3 wk. By day 78 the cumulative load of chemical oxygen demand had been reduced by 37% and the P by 48%. In the sand filter the reduction in chemical oxygen demand started immediately and concentrations in the effluent remained low and steady from day 18

until day 78, when the last sampling was made. The total reduction in chemical oxygen demand amounted to 91%. Effluent concentrations of P were initially low but increased as the experimental period progressed. The total decrease in P in the sand filter was 83%. The reduction in chemical oxygen demand was highest in the upper 1.5 cm of the sand profile and was almost complete after 15 cm of infiltration; in contrast, P levels showed an overall decrease throughout the sand profile. The columns were less efficient at reducing chemical oxygen demand but more efficient at deceasing P compared with the sand filter. The results from the columns suggest that anaerobic conditions had developed. (See also W90-04104 thru W90-04105) (Author's abstract)
W90-04103

INFILTRATION OF WASTEWATER IN A NEWLY STARTED PILOT SAND-FILTER SYSTEM: II. DEVELOPMENT AND DISTRIBUTION OF THE BACTERIAL POPULATIONS.
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
M. Pell, and F. Nyberg.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 457-462, October-December 1989. 4 fig, 1 tab, 40 ref.

Descriptors: *Wastewater treatment, *Sand filters, *Bacterial analysis, *Aerobic bacteria, Septic tanks, Denitrification, Sulfur bacteria, Filtration, Pilot plants.

The objective of the study was to monitor the development of the bacterial populations in a sand-filter system consisting of a three-chambered septic tank, a sand filter with a one-person capacity, and eight columns. The system was loaded with 67 L/sq m/d of an artificial wastewater. Monitoring was conducted from start-up until a steady state was reached. The wastewater contained over two orders of magnitude higher numbers of aerobic bacteria in the third chamber compared to the first chamber of the septic tank. Populations of aerobic and denitrifying bacteria in the sand surface layer of the columns increased markedly in number within the first 10 days, reaching peaks on day 24. The following decline was attributed to the development of anaerobic conditions. This hypothesis was supported by an observed increase in the number of sulfate-reducing bacteria. No increase in nitrifier populations was observed. In the sand-filter surface layer both aerobic and denitrifying bacteria increased in numbers until days 65 to 75, thereafter remaining in a steady state at around 100,000,000 bacteria/g dry sand. Populations of ammonium-oxidizing and nitrite-oxidizing bacteria both started out at low levels. Thereafter they increased until days 70 to 95, by which time populations of 1,000,000 to 10,000,000 (ammonium-oxidizing bacteria) and 100,000 to 1,000,000/g dry sand (nitrite-oxidizing bacteria) had been established. By the time that bacterial growth had reached a steady state, an estimated 8% of the pore volume in the sand surface layer was occupied by bacterial cells. This biomass accounts for the amounts of N and P in the sewage water produced by one person during a 20-day period. (See also W90-04103 and W90-04105) (Author's abstract)
W90-04104

INFILTRATION OF WASTEWATER IN A NEWLY STARTED PILOT SAND-FILTER SYSTEM: III. TRANSFORMATION OF NITROGEN.
Sveriges Lantbruksuniversitet, Uppsala. Institutionen foer Mikrobiologi.
M. Pell, and F. Nyberg.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 463-467, October-November 1989. 5 fig, 2 tab, 25 ref.

Descriptors: *Wastewater treatment, *Sand filters, *Nitrogen compounds, Chemical reactions, Mineralization, Pilot plants, Filtration, Septic tanks, Nitrates.

The objective of the study was to monitor the chemical dynamics associated with N transformations from start-up until a steady state was reached in a pilot sand-filter system consisting of a three-chambered septic tank, a sand filter with a one person capacity, and eight columns. The system was loaded with 67 L/sq m/d of an artificial wastewater. The untreated wastewater contained 114 mg Kjheldahl N/L and 0.12 mg NH4(+)-N/L. Mineralization reached a steady state in the septic tank after 2 wk of operation; thereafter, 65 +/-6% of the effluent N was NH4(+)-N. In the column effluent the concentrations of NH4(+)-N increased during the first 6 wk of operation, whereafter a stabilization at 60 to 80 mg NH4(+)-N/L occurred. The mean proportion of effluent N in mineralized form for the whole period was 88 +/-6%. Three weeks after start-up, all effluent N from the sand filter was in mineralized form and remained high for the rest of the study period. The effluent concentrations of NH4(+)-N increased rapidly during the first 2 wk after which it decreased to less than 3 mg/L. The concentration of NO3(-)-N was initially low. It then increased until about day 30 when it stabilized at 64 to 71 mg NO3(-)-N/L. Elevated concentrations of NO2(-)-N were observed between days 8 and 45. Nitrifying activity reached a steady state after 6 wk of operation. During this state a considerable amount of nitrification took place in the upper 1.5 cm and all wastewater N had been nitrified after 15 cm of percolation. By the end of the operating period the total amount of influent N in the septic tank had been reduced by 17%. Corresponding reductions for the columns were 18% and for the sand 33%. (See also W90-04103 thru W90-04104) (Author's abstract)
W90-04105

PROTECTIVE COATINGS AT A WASTEWATER TREATMENT PLANT.
Willow Lake Wastewater Treatment Plant, Salem, OR.
P. Eckley, and T. Plumb.
Public Works PUWOAH, Vol. 120, No. 11, p 73-74, 102, November 1989. 2 tab.

Descriptors: *Wastewater facilities, *Coatings, *Construction materials.

Protecting wastewater treatment plant components with suitable coatings prolongs the equipment's useful life and promotes aesthetics as well. The management of a Salem, Oregon treatment plant has embarked on a program to keep the Willow Lake Wastewater Treatment Plant's protective coatings maintained at all times using appropriate coating systems for different environments. This is being achieved despite periodic heavy industrial loadings and a rainy season that limits the painting season. Steel surfaces with severe environment exposure and nonsubmerged exteriors such as clarifier catwalks and tanks receive three coats: a primer of polyamide epoxy, an intermediate of high solids epoxy and an acrylic polyurethane enamel finish. Submerged steel and concrete are painted with amine cured or polyamide cured epoxy. Nonsubmerged interior metal such as piping, fittings, tanks and pumps are coated with amine cured epoxy. Metal doors and piping with severe exposure receive a primer of high solids epoxy and an acrylic polyurethane enamel finish. Besides developing good coating specifications, the following are also important: Keep coating systems simple; do not contract too big an annual project that cannot reasonably be finished within the coating season; keep the plant staff up to date of the project's status; provide good planning and communication with the contractor to avoid confusion; and optimize time frames, but have some alternatives. (Mertz-PTT)
W90-04115

PH VARIATION DURING PHENOL BIODEGRADATION IN MIXED CULTURES OF MICROORGANISMS.
Cagliari Univ. (Italy). Dipt. di Ingegneria Chimica e Materiali.
A. Lallai, and G. Mura.
Water Research WATRAG, Vol. 23, No. 11, p 1335-1338, November 1989. 4 fig, 1 tab, 16 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Phenols, *Biodegradation, *Aerobic bacteria, Hydrogen ion concentration.

The behavior of pH was investigated in two mixed microbial cultures growing aerobically in a batch reactor with phenol as the limiting substrate. A buffered synthetic medium was used, and, in all experiments, a variation in pH was observed. It was noted that the pH first decreased, and then increased. The initial phenol concentrations used in the experiments ranged from 60-1000 mg/L, for the first culture (Phenobac) and from 50-600 mg/L, for the second (Polybac). From the results obtained, it appears that the extent of the drop in pH depends upon the initial phenol concentration. These findings serve as an important base for the development of a simplified system for the control of batch activated sludge process applied to the treatment of phenolic effluents. By only measuring the pH of the mixed liquor, useful indications are given as to the understanding the process of purification in terms of the disappearance of phenol (minimum of pH) and the end of fermentation (stabilized pH). (Author's abstract)
W90-04140

MAINTAINING NITRITE BUILD-UP IN A SYSTEM ACCLIMATED TO FREE AMMONIA.
NovaTec Consultants, Inc., Vancouver (British Columbia).
O. Turk, and D. S. Mavinic.
Water Research WATRAG, Vol. 23, No. 11, p 1383-1388, November 1989. 3 fig, 3 tab, 23 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge, *Nitrites, *Ammonia, *Nitrogen removal, Retention time, Substrate inhibition, Nitrification.

A research program was designed to study process changes that could be used to maintain nitrite build-up and overcome the effects of acclimation to free ammonia (FA) and allow the use of a shortened nitrification/denitrification pathway for nitrogen removal from highly nitrogenous wastes. The study employed bench-scale, activated sludge cells. Measures investigated to overcome the effects of acclimation were: (1) increasing mixed liquor suspended solids wastage by a factor of five; (2) extension of contact time to high FA levels to 50% of the total retention time; (3) raising FA concentrations to 40 mg NH3-N/L; (4) use of a more complex substrate (municipal landfill leachate); (5) double substrate inhibition (FA and sodium chlorate); (6) provision of internal denitrification; and (7) temporary reduction of FA levels. Of these, the most effective was internal denitrification. (Author's abstract)
W90-04145

EFFECT OF TEMPERATURE, PH AND DO CONCENTRATION ON FILTERABILITY AND COMPRESSIBILITY OF ACTIVATED SLUDGE.
Middle East Technical Univ., Ankara (Turkey). Dept. of Environmental Engineering.
G. Surucu, and F. D. Cetin.
Water Research WATRAG, Vol. 23, No. 11, p 1389-1395, November 1989. 5 fig, 6 tab, 19 ref.

Descriptors: *Activated sludge, *Wastewater treatment, *Sludge conditioning, *Dewatering, Temperature, Hydrogen ion concentration, Dissolved oxygen, Filterability, Compressibility, Effluents.

The effects of aeration basin temperature, pH and dissolved oxygen (DO) concentration on filterability and compressibility characteristics of activated sludge were investigated. Laboratory-scale, semi-continuous reactors fed with synthetic wastewater were used. Effects of temperatures of 15, 20, 25, 30, and 35 C; pH values of 5.7, 7.2, 8.2, and 9.0; and DO concentrations of 0.5, 1.0, 1.5, 2.0, and 5.0 ml/L were studied by keeping all the other parameters constant in each case. Results indicated that as the operating temperatures of reactors were increased, specific resistances to filtration also increased. Up to 25 C a decrease in compressibility

of the sludges was observed and above 25 C the sludges became more compressible. Similarly, as the operating pH of the reactors was increased, sludge filterabilities decreased. Increases in the pH of the reactors caused the sludges to become more compressible. On the other hand, low aeration basin DO concentrations reduced the filterability of sludges and caused the formation of low compressible sludges and poor effluent qualities. At higher DO concentrations higher filterabilities, better effluent qualities and more compressible sludges resulted. (Author's abstract)
W90-04146

MEDIA EFFECTS ON PERFORMANCE OF ANAEROBIC HYBRID REACTORS.
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
K. J. Kennedy, S. S. Gorur, C. A. Elliott, E. Andras, and S. R. Guiot.
Water Research WATRAG, Vol. 23, No. 11, p 1397-1405, November 1989. 8 fig, 4 tab, 14 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Wastewater reactors, Upflow sludge blanket filter, Chemical oxygen demand, Retention time.

Effects of cross-flow media angle and depth on hybrid anaerobic upflow-sludge-blanket-filter (UBF) reactors treating a medium strength wastewater were investigated. Results showed that media angle, media depth and sludge bed height had a relatively minor effect on sludge retention and COD removal while hydraulic retention time (HRT) and concomitant volumetric organic loading rate (OLR) had the largest impact. Variations in sludge granulation were noted, with the proliferation of more settleable granules in the reactor containing random media and UBF reactor with the shallow packing slope. Although the settleability of the sludge in each UBF varied, the sludge activity in all reactors was relatively constant. Since cross-flow media depth and angle had little influence on solids retention and COD removal efficiency, significant capital cost savings can be made by decreasing the volume of media to about 10% without causing detrimental effects to UBF reactor performance. (Sand-PTT)
W90-04147

FATE OF 2,4-D IN MICROBIAL CULTURES.
Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
D. Orhon, I. Talinli, and O. Tunay.
Water Research WATRAG, Vol. 23, No. 11, p 1423-1430, November 1989. 6 fig, 8 tab, 18 ref.

Descriptors: *Wastewater treatment, *Phenoxy acid herbicides, *Herbicides, *Biodegradation, *Fate of pollutants, Culture media, Substrates.

2,4-D, as one of the most frequently used herbicides, finds access to treatment plants and receiving waters at a significantly increasing rate. These types of organics are commonly investigated either for their toxic properties or their biodegradability. The accumulated information becomes, at times, misleading since 2,4-D, like most similar chemicals, may be a substrate alternately or concurrently, depending on the characteristics of the environment in which it reacts. The fate and impact of 2,4-D in microbial cultures under different conditions was investigated. It was found that 2,4-D at short exposure to a microbial culture grown on a Bacto nutrient/sodium acetate mixture (BNB) remains non-biodegradable, inhibiting the BNB removal rate. The biodegradation of 2,4-D in the same culture is subject to acclimation after 20-40 days. Upon acclimation, 2,4-D is biodegradable as a single substrate or combined with the BNB solution. Its removal may be interpreted by a non-interactive mechanism suggesting the development of a growth pattern at high 2,4-D concentration. In multi-substrate environments the BNB removal rate is significantly affected by 2,4-D inhibition. The fate and impact of 2,4-D in microbial cultures under different conditions shows inherent similarities with those of phenol. (Author's abstract)
W90-04150

DETERMINATION OF KINETIC CONSTANTS OF ACTIVATED SLUDGE MICROORGANISMS RESPONSIBLE FOR DEGRADATION OF XENOBIOTICS.
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmental Protection.
J. Chuboda, J. Albokova, and J. S. Cech.
Water Research WATRAG, Vol. 23, No. 11, p 1431-1438, November 1989. 7 fig, 8 tab, 21 ref.

Descriptors: *Activated sludge, *Wastewater treatment, *Biological wastewater treatment, *Pollutants, Biodegradation kinetics, Morpholine, Sulfanilic acid, Nitrilotriacetic acid, Methanol, Retention time.

Experiments with the degradation of morpholine (MO), sulfanilic acid (SA), nitrilotriacetic acid (NTA) and methanol (MA) were carried out in completely-mixed systems at constant volumetric loading and variable solids retention time (SRT). Respirometric studies were carried out with excess biomass in order to determine the following kinetic parameters: yield coefficient (Y), half-velocity coefficient, maximum volumetric removal rate and maximum specific removal rate. Both maximum volumetric removal rate and maximum specific removal rate depend on the SRT of a mixed culture. A method of determining the critical solids retention time at which maximum volumetric removal rate = volumetric loading was developed. At the minimum solids retention time, all microorganisms responsible for the degradation of a given compound are washed out from the cultivation system. The developed method also makes it possible to determine maximum specific removal rate, maximum specific growth rate, and the decay coefficient of the microorganisms in a mixed culture responsible for the degradation of xenobiotics. The results indicate that the microorganisms responsible for the degradation of the xenobiotics are slow-growing. A kinetic equation based on maximum volumetric removal rate and half-velocity coefficient was derived and shown to accurately predict effluent concentrations of the tested compounds at all SRT. None of the tested compounds supported filamentous bulking in completely-mixed reactors under the technological parameters used. (Author's abstract)
W90-04151

BIODEGRADATION OF 2,4-DICHLOROPHENOL BY ACTIVATED SLUDGE MICROORGANISMS.
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmenta; Protection.
J. Chudoba, J. Albokova, B. Lentge, and R. Kummel.
Water Research WATRAG, Vol. 23, No. 11, p 1439-1442, November 1989. 4 fig, 7 tab, 8 ref.

Descriptors: *Activated sludge, *Wastewater treatment, *Biological wastewater treatment, *Biodegradation, *Chlorinated hydrocarbons, Xenobiotics, Pollutants, Dichlorophenol.

Experiments with the degradation of 2,4-dichlorophenol (2,4-DCP) were carried out in completely-mixed systems at constant volumetric loading and variable solids retention time (SRT). A mixed substrate consisted of 2,4-DCP (20% of total COD) and methanol (MA, 80% of total COD). The maximum specific rate of 2,4-DCP removal related to the total biomass in the cultivation system, increased with the decreasing SRT from 0.0118/h at the SRT of 10.8 d up to 0.0783/h at the SRT of 0.6 d. The following values of kinetic constants of microorganisms responsible for the degradation of 2,4-DCP were found (20 C and pH = 7.5): COD yield constant = 0.37, COD half-velocity constant = 0.6 mg/L, maximum specific substrate removal rate = 0.233/h, biomass decay rate constant = 0.036/h, maximum specific growth rate = 0.086/h and critical value of SRT = 0.083 d. (Author's abstract)
W90-04152

BIOCATALYTIC ADDITION: DOES IT AID ANAEROBIC DIGESTION.
National Univ. of Singapore. Dept. of Civil Engineering.
L. C. C. Koe, and F. G. Ang.
Water Research WATRAG, Vol. 23, No. 11, p 1455-1459, November 1989. 1 fig, 5 tab, 16 ref. National University of Singapore Research Grant Nr. RP870633.

Descriptors: *Activated sludge, *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Fatty acids, Biocatalysts.

Laboratory reactors were set up to study the anaerobic treatment of primary sludge loaded with high levels of free fatty acids under the influence of a commercial biocatalyst. Chemical oxygen demand, total solids, total volatile solids, pH, alkalinity, total volatile acids, gas production and gas quality were monitored. By comparing the organic destruction parameters, it was found that the biocatalytic additive did not aid the anaerobic treatment of such waste in the range of the concentration of free fatty acids investigated. These results did not agree with the findings of previous studies. The reason for this discrepancy could be due to the fact that the reactors in the laboratory were healthy prior to the addition of the biocatalyst. There may be a difference if the reactors were 'in trouble', or when the organic loadings were increased to such an extent as to induce a failure in the process. (Author's abstract)
W90-04155

PREDICTING MASS TRANSFER RATES IN RBC FOR NON-NEWTONIAN FLUIDS.
Bombay Univ. (India). Dept. of Chemical Technology.
R. N. Vaidya, and V. G. Pangarkar.
Water Research WATRAG, Vol. 23, No. 11, p 1461-1464, November 1989. 3 fig, 12 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Mass transfer, *Contactors, Nonnewtonian fluids, Rotating biological contactors, Adsorption, Model studies.

This technical note expands the scope and applicability of earlier models for mass transfer in rotating biological contactors to the cases where the fluid is non-Newtonian. It was assumed that the film thickness remains constant over its entire length of travel, i.e. from the point the fluid is withdrawn from the liquid pool to the point it is returned back to the pool. This assumption has been shown to be fairly satisfactory for Newtonian fluids under certain operating regimes. The convective diffusion equation was then solved numerically with the appropriate initial and boundary conditions for the entire exposed surface area of the disc. It is shown that a priori predictions for rates of absorption (or mass transfer coefficients) into non-Newtonian fluids is possible, and excellent agreement with experimental data was observed. (Author's abstract)
W90-04156

EDUCATING RURAL COMMUNITY LEADERS IN WASTEWATER TREATMENT ALTERNATIVES.
Ohio State Univ., Columbus. Dept. of Agricultural Engineering.
K. Mancl.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 985-989, October 1989. 1 tab, 9 ref.

Descriptors: *Ohio, *Wastewater treatment, *Wastewater facilities, *Education, Surveys, Rural areas, Economic aspects.

Providing adequate wastewater treatment facilities for the citizens in small rural communities in the United States can cost millions of dollars. An educational program has been developed and conducted in Ohio to teach local officials about wastewater treatment alternatives. The five-session workshop covers wastewater treatment principles, needs assessment, system management, and resource gathering. The knowledge and skills gained by the 96 community leaders who participated in six workshops were measured using a pretest/post test and

surveys conducted during the workshops. From 25 percent to 100 percent of the participants increased their knowledge of treatment systems, alternatives, and relative costs. From 23 percent to 84 percent applied new skills, such as conducting a sanitary survey or examining treatment systems. The pretest also revealed previous knowledge of the participants in the areas of system maintenance and consultant qualifications. (Author's abstract)
W90-04202

COMPLETE DOCUMENTATION OF THE SYSTEM/USER MANUAL FOR THE RISK ASSESSMENT MODELS FOR LAND APPLICATION OF MUNICIPAL SLUDGES (RAMMS VERSION 3.0): VOLUME I.
Science Applications, Inc., McLean, VA.
For primary bibliographic entry see Field 7B.
W90-04248

REDUCTIONS OF ENTERIC MICROORGANISMS DURING AEROBIC SLUDGE DIGESTION: COMPARISON OF CONVENTIONAL AND AUTOHEATED DIGESTERS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
J. H. Martin.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-138846. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/2-88/072, January 1989. 111p, 32 fig, 35 tab, 32 ref, 3 append. EPA Contract CR-811776.

Descriptors: *Wastewater treatment, *Enteric bacteria, *Aerobic digestion, *Sludge digestion, Salmonella, Temperature, Mathematical studies, Sludge stabilization, Volatile solids, Enteroviruses, Comparison studies.

The objectives of this investigation were to: (1) determine the seasonal variations in sludge stabilization and reductions in the densities of indicator organisms, Salmonella spp., and enteroviruses that occur with conventional aerobic digestion in cold climates, and (2) demonstrate that both sludge stabilization and reductions in the densities of these microorganisms can be improved by simple modifications that increase process temperature. Two 32 cu-m aerobic digesters located at a small municipal wastewater treatment plant were operated continuously over a period of 20 months to obtain the data necessary to satisfy these objectives. One digester was a conventional digester while the other was designed to minimize heat losses and thus, facilitate autoheating. Conventional digester mixed liquor temperatures at the constant residence time of 20 days ranged from a minimum of 8 C to a maximum of 26 C over the 20 months of operation. In contrast, the range of autoheated digester mixed liquor temperatures for residence times of 10, 15, and 20 days was substantially higher, 29 C to 40 C, even with relatively dilute sludges. Enteroviruses were found to be most sensitive to the effect of temperature increases while fecal streptococci were the most resistant. No strong linear relationships were observed between first-order reaction rate coefficients for three of the parameters used to characterize sludge stabilization; total volatile solids, chemical oxygen demand, and organic nitrogen; and mixed liquor temperature. When residence times necessary to provide a 38% reduction in volatile solids concentration are compared to residence times necessary to realize a two log 10 reduction in indicator organisms and enteroviruses for mixed liquor temperatures up to 40 C, residence time for microbial rather than volatile solids reductions appeared to be the critical design parameter for aerobic sludge digestion. At mixed liquor temperatures above 40 C, this situation may be reversed, however, given previously reported results from studies of autoheated thermophilic digestion. (Lantz-PTT)
W90-04252

KINETICS OF ENDOGENOUS DECAY, DEATH, AND LYSIS FOR VIABLE ORGANIC SOLIDS.
Arizona Univ., Tucson.
C. W. Bryant.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-148522. Price codes: A06 in paper copy, A01 in microfiche. Report No. NSF/ENG-88011, July 1988. 138p, 56 fig, 40 tab, 101 ref, 4 append. NSF Grant 85-05233.

Descriptors: *Wastewater stabilization, *Kinetics, *Wastewater treatment, Organic matter, Anaerobic digestion, Aerobic digestion, Lysis, Stabilization, Organic compounds, Sludge digestion, Sediment-water interfaces.

The set of reactions which convert particulate organic matter to soluble components is of major importance in the stabilization of particulate organic wastes, the aerobic and anaerobic digestion of by-product biological sludges, and the feedback of consolidating benthal deposits to overlying water columns. The research was designed to produce an improved explanation of aerobic and anaerobic solubilization for a full range of applications. The objective of the research was to evaluate the net kinetic rates for indicators of endogenous decay, biomass death, and lysis. The effects of terminal electron acceptor, temperature, and input solids age were evaluated. The definition of the net kinetic rates of decay, death, and lysis as functions of these environmental factors enhances the understanding of any wastewater stabilization process. (Author's abstract)
W90-04261

MOST APPROPRIATE ONGOING WASTEWATER INSTITUTIONS (ORGANIZATION FOR AREAWIDE WATER QUALITY PLANNING).
Colorado State Univ., Fort Collins. Dept. of Political Science.
For primary bibliographic entry see Field 6E.
W90-04360

METALS SPECIATION, SEPARATION, AND RECOVERY.
Proceedings of the International Symposium on Metals Speciation, Separation and Recovery, Chicago, Illinois, July 27-August 1, 1986. Lewis Publishers, Chelsea, Michigan. 1987. 779p. Edited by James W. Patterson and Roberto Passino.

Descriptors: *Heavy metals, *Waste recovery, *Separation techniques, *Wastewater treatment, *Metal complexes, *Path of pollutants, Chemical treatment, Metals, Symposium, Chemical reactions, Molecular structure, Kinetics, Ion exchange.

The symposium proceedings contain three keynote papers and 26 scientific and technical papers together with a written discussion of each paper. The keynote papers cover changes in metal mobilities in aquatic and terrestrial cycles; general affinity concepts, equilibria, and kinetics in aqueous metals chemistry; and metals separation and recovery. The other 26 papers are categorized in one of seven sections: crystallization and precipitation phenomena; models and methods of metals speciation; membrane and biological processes; ligand design and kinetic controls of metals speciation; sorption on surface oxides; ion exchange separations; and process research on metals recovery applications. (See W90-04371 thru W90-04391) (VerNooy-PTT)
W90-04370

METALS SEPARATION AND RECOVERY.
Illinois Inst. of Tech., Chicago.
J. W. Patterson.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 63-93, 2 fig, 9 tab, 23 ref.

Descriptors: *Metals, *Waste recovery, *Separation techniques, *Waste management, *Wastewater treatment, Chemical treatment, Fate of pollutants, Water pollution control, Economic aspects.

There is a need for a reassessment of current policies for and methods of managing toxic metal pollutants. Metals are conservative elements which cannot be destroyed nor detoxified by modern technologies. Current waste metals management practices are implemented to comply with applicable federal, state and local regulations. However, selection among technologically feasible alternatives is normally dominated by near-term (1 to 10 years) economic considerations. The principal technologies for metals separation can be subdivided into three categories: conventional treatment technologies; recognized recovery technologies; and emerging recovery technologies. Conventional methods include precipitation, oxidation, reduction or concentration coupled with precipitation, and secondary coprecipitation. Recognized recovery technologies include evaporative recovery, ion exchange, membrane separation, and reductive electrolysis. Differential precipitation, extractive metallurgy and selective adsorption are some of the emerging technologies. Despite current diseconomies associated with utilization of recovery over conventional treatment technologies, there are economic tradeoffs which should with time shift economics in favor of recovery. These include improvements in the efficiency and selectivity of recovery technologies, increases in metals market values, and avoidance or reduction of future liabilities associated with current residue disposal practices. (See also W90-04370) (VerNooy-PTT)
W90-04373

USE OF THIOUREA AND THIOACETAMIDE FOR SEPARATION AND RECOVERY OF HEAVY METALS FROM MINERAL TREATMENT WASTE WATERS.
Nevada Univ., Reno.
J. H. Nelson, J. L. Hendrix, and E. Milosavljevic.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 119-140, 5 tab, 18 ref. US Bureau of Mines, Grant G1125132-3205.

Descriptors: *Chemical precipitation, *Ureas, *Wastewater treatment, *Heavy metals, *Separation techniques, Chemical treatment, Waste recovery, Metal-finishing wastes, Cations, Metals, Thiourea, Thioacetamide, Chemical reactions.

A study was conducted to test the effectiveness of using thiourea and thioacetamide to precipitate metals from wastewater streams. The initial portion of the study determined the ability of thiourea and thioacetamide to precipitate specific metallic cations as either sulfides or oxides. Metal cations tested included Cu, Fe, Zn, Co, Pb, Cr, Mn, Mg, Cd, Ni, As, Hg, and Sb. Tests were also conducted using solutions from metallurgical process streams, including two chloride leach washes and a sulfuric acid wash. Most metals were removed within the 96% to 99% range. Thiourea did not precipitate arsenic, whereas thioacetamide did precipitate it as a sulfide. Thioacetamide was a more effective precipitant than either sodium sulfide (Na2S) or thiourea. Compared to Na2S, this is due to the slower rate of formation of metal sulfides which gives rise to better filterability. Compared to thiourea, this is due to the faster rate of sulfide formation due to hydrolysis of the thioacetamide as evidenced by the kinetic studies. Preliminary studies concerning the hydrolysis of thiourea and thioacetamide have been conducted. (See also W90-04370) (VerNooy-PTT)
W90-04374

EFFECT OF CITRATE, A WEAK CHELATING AGENT, ON THE REMOVAL OF HEAVY METALS BY SULFIDE PRECIPITATION.
Purdue Univ., Lafayette, IN.
R. W. Peters, and Y. Ku.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 147-169, 16 fig, 8 tab, 15 ref.

Descriptors: *Chelating agents, *Chemical precipitation, *Sulfides, *Wastewater treatment, *Heavy metals, Metal-finishing wastes, Cations, Citrate, Separation techniques, Metals, Chemical treatment.

Heavy metal removals and particle size distributions are presented for both hydroxide precipitation and sulfide precipitation of zinc, cadmium, and

copper in the presence of a weak chelating agent, citrate. Both batch and continuous precipitation experiments were performed. Experimental conditions investigated included initial citrate concentrations from 0 to 900 mg/L, initial metal concentrations from 0 to 200 mg/L, pH from 4 to 10, and 0 to 60 min reaction time. The presence of citrate had little effect on the chemical equilibrium for both the hydroxide and sulfide precipitation systems due to the weak complexing ability with metal ions. Citrate does affect the particle size distribution through a nucleation/growth inhibition mechanism, generally forming smaller particles. Sulfide precipitation exhibits a better particle size distribution and settling characteristics than the corresponding metal hydroxide precipitation. Due to the narrow particle size distributions achieved, sedimentation by itself is an ineffective solid-liquid separation technique for these heavy metal systems. Citrate may cause a coagulation effect on continuous ZnS precipitation enhancing the particle size distribution. Excellent metal removals are achieved using sulfide precipitation even in the presence of weak complexing agents (provided a very effective filtration system is employed) due to the small size of the precipitates; otherwise considerably larger metal concentrations are measured using a less effective filtration system. (See also W90-04370) (Author's abstract)
W90-04375

KINETICS AND YIELD OF THE MAGNESIUM CEMENTATION OF CADMIUM.
Georgia Inst. of Tech., Atlanta.
J. P. Gould, B. M. Khudenko, and H. F. Wiedeman.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 175-190, 10 fig, 4 tab, 15 ref.

Descriptors: *Cadmium, *Magnesium, *Kinetics, *Wastewater treatment, *Waste recovery, Chemical treatment, Heavy metals, Separation techniques.

This paper describes the results of studies on the cementation of cadmium using magnesium as the sacrificial metal. Cementation experiments were conducted in a 2 liter completely mixed batch reactor. Magnesium cementation of cadmium was shown to have the potential of reducing the concentration of cadmium to a substantial extent, especially at moderate to high initial concentration levels (200 to 5000 mg/L), with recovery of pure metallic cadmium. The reaction mechanism over this range passed from a migration controlled regime through a migration/diffusion mechanism to diffusion control at higher initial cadmium concentrations. The reaction rate appeared to be at its maximum in the concentration range corresponding and adjacent to the transition between mechanisms. Dependence on pH was very slight, which was consistent with the fact that cadmium speciation was largely pH independent over this range. Reaction stoichiometry was least favorable at lowest initial cadmium concentrations and lowest pH values indicating effective loss of magnesium to attack by hydrogen ions. The stoichiometry very rapidly improved to theoretical at all pH levels as initial cadmium concentration increased. This is very significant with respect to system economics. Many factors will have to be considered in a full analysis of a cementation system for treatment of cadmium bearing wastewater including cost of operation, maintenance and processing of the cementate, reduced costs for hazardous waste disposal, etc. Economically however, magnesium cementation shows every indication of being an acceptable alternative for cadmium removal from wastewaters. (See also W90-04370) (VerNooy-PTT)
W90-04376

LIQUID MEMBRANES FOR METAL ION REMOVAL FROM AQUEOUS MEDIA--AN OVERVIEW.
Stauffer Chemical Co., Richmond, CA.
R. P. Borwankar, D. T. Wasan, and N. L. Li.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 289-306, 3 fig, 1 tab, 56 ref.

Descriptors: *Membrane processes, *Metals, *Oil-water interfaces, *Emulsions, *Wastewater treatment, Cations, Separation techniques, Mathematical models, Literature review.

Membrane-based separation processes are attracting considerable attention in recent years due to their potential for low capital cost and energy efficiency. The liquid surfactant membrane (LSM), can offer greater areas for transport than supported membrane systems. LSM systems have several advantages over a conventional solvent extraction process; extraction and stripping occur simultaneously, which also increases the capacity of the process. LSM systems are well-suited for wastewater treatment because, by employment of facilitation mechanisms, the solute can be effectively transported against its concentration gradient, thereby concentrating the contaminant in a smaller stream. A review is made of significant recent developments in separating metal ions using LSM, and considerable attention is devoted to extraction of transition metal cations. The development of a mathematical model of the extraction process is summarized. Areas requiring further research, such as encapsulated phase leakage and demulsification of spent emulsions, are also identified. (See also W90-04370) (VerNooy-PTT)
W90-04379

ALGAL SORBENTS FOR SELECTIVE METAL ION RECOVERY.
New Mexico State Univ., Las Cruces.
B. Greene, R. McPherson, and D. Darnall.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 315-332, 12 fig, 1 tab, 13 ref.

Descriptors: *Algae, *Chlorella, *Cyanophyta, *Metals, *Sorption, *Biological wastewater treatment, *Wastewater treatment, Waste recovery, Ion exchange.

The cells of algae, fungi and bacteria, exhibit high sorptive capacities for different metal ions in aqueous solutions. Algal cells function like a mixture of ion exchange resins. The mechanisms of metal ion binding may involve cation exchange, anion exchange, or reduction/adsorption. Experimental results suggest some important applications of algal sorbent technology to the selective removal and recovery of metal ions from waters. Experiments were performed in either a batch or column configuration. In batch configuration, lyophilized algal cells or immobilized preparations were suspended in the metal solution containing ions of Al, Cd, Cr, Co, Cu, Pb, Ni, Ag, and Zn. Column experiments were performed by passing the metal solution through a column containing immobilized algal cells. Depending on the metal ions and the conditions, C. vulgaris, C. pyreniodosa, and Spirulina in lyophilized and immobilized forms can be used to remove toxic or precious metal ions from a variety of aqueous solutions. In several cases, selective binding of certain metal ions occurs as a function of pH, the presence of competing ligands, or the presence of competing metal ions. Depending upon conditions, most metal ions can be selectively recovered from the algal cells using a pH gradient and/or adding specific ligands. Once stripped free of metal ions, the algal cells are effectively regenerated. Thus the algal sorbents offer an attractive method for wastewater treatment and for recovery of metal ions from mining process streams. (See also W90-04370) (VerNooy-PTT)
W90-04380

KINETICS OF CADMIUM AND COPPER COMPLEXATION.
Illinois Inst. of Tech., Chicago.
C. N. Haas, J. W. Patterson, R. J. Vamos, E. Cooney, and K. Topudurti.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 385-398, 8 tab, 22 ref.

Descriptors: *Kinetics, *Cadmium, *Waste recovery, *Copper, *Metal complexes, *Wastewater treatment, Heavy metals, Chemical treatment, Mathematical models.

Two important heavy metal pollutants with potential economic value are cadmium and copper. Since metals are often present in effluents in association with many other pollutants, recovery of these metals by precipitation necessitates selective removal. Experiments were preformed to obtain data on the homogeneous complexation kinetics of cadmium(II) and copper(II) with hydroxide, and cadmium(II) with chloride. The modeling equations developed to analyze both the titration and the kinetic data were non-linear in nature. The model developed appears to be readily adaptable to the measurement of reaction rates for metal complexation reactions under conditions of environmental interest. In principle, for any system in which a sensitive assay is available for free metal and free ligand concentrations, the steady state CSTR (completely mixed continuous stirred tank reactor) approach appears capable of producing useful results. The measured rates of cadmium and copper complexation are not instantaneous. This may afford the basis of a kinetically-based separation process for metal ions from aqueous systems. Work is in progress to test the developed rate and equilibrium equations in multicomponent systems. (See also W90-04370) (VerNooy-PTT)
W90-04381

ION EXCHANGE KINETICS IN SELECTIVE SYSTEMS.
Akademiya Nauk SSSR, Moscow. Inst. Fizicheskoi Khimii.
A. I. Kalinitchev, T. D. Semenovskaya, and E. V. Kolotinskaya.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 403-425, 10 fig, 2 tab, 39 ref.

Descriptors: *Kinetics, *Ion exchange, *Mathematical models, *Resins, *Metals, *Wastewater treatment, Chemical reactions, Mathematical analysis, Diffusivity, Computer models.

The numerous studies on ion exchange kinetics demonstrate that in some cases the diffusion mechanism is complicated by additional interactions. Ion exchangers are widely used for the extraction of metals from wastewater and natural waters. An ion exchange model was studied including the chemical reactions, which describes a two-component system. The model takes into account the effect of the interference of two components on the process of interdiffusion. Usually the kinetics of ion exchange in real systems is estimated from the experimental dependence F-t and from bead section microphotographs taken at various times. Data on the equilibrated ion distribution between the exchanger and the solution were found from independent static experiments. The experiments were conducted on vinyl pyridine carboxyl ampholyte VPC, carboxyl cationite KB-4 and weak-basic anionite AN-18. The exchange rate in exchangers VPC and AN-18 was measured by a thin-layer technique. Results revealed that the dependencies of the mass exchange rate in the exchanger phase on the solution concentration and parameters of the exchange isotherm, revealed by theoretical studies, are also observed in the real systems during the exchange accompanied by formation of weakly dissociating compounds. Comparison of the experimental and numerical results showed a good quantitative agreement of the kinetic curves. (See also W90-04370) (VerNooy-PTT)
W90-04382

CHEMICAL INTERACTIONS BETWEEN HEAVY METAL IONS AND HYDROUS SOLIDS.
Delaware Univ., Newark.
C. P. Huang, Y. S. Hsieh, S. W. Park, M. Ozden Corapcioglu, and A. R. Bowers.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 437-465, 18 fig, 9 tab, 50 ref. EPA Grant 808141 and NSF Grants CEE 8104728, CEE 8313290, and 8406293.

Descriptors: *Path of pollutants, *Adsorption, *Wastewater treatment, *Metal complexes, *Heavy metals, Chemical reactions, Cations, Hy-

drogen ion concentration, Acidity, Interfaces, Adsorbents, Model studies, Mathematical models.

Adsorption reaction is a common process in water and wastewater treatment and in the transport of chemical species in the aquatic system. The adsorption of metal ions, such as Cu(II), Co(II), Sn(II), Pb(II), Hg(II), Cd(II) and Ni(II) onto various hydrous solids, e.g. Al2O3, SiO2, Fe(OH)x, CdS(s), TiO2, and activated carbon, was studied using pH as the master variable. The extent of metal adsorption is also affected by the surface loading, the type of solid and the type of metal ion involved. A surface complex formation model, with modification, is used to describe the adsorption behavior. Stability constants and speciation of the surface complexes are shown, as well as the effect of complexing ligands on the adsorption of metal ions. Results indicate that both the surface acidity and the acidity of the metal ions play an important part in metal adsorption. The percent of metal removed increases with decreasing loading; the adsorption density, however, increases with increasing surface loading. Surface complex formation by including all metal hydrolysis species provides a simple method for quantifying the extent of metal adsorption. This model requires information on the surface acidity and the aqueous chemistry of metal speciation. Among the solids examined, TiO2, SiO2 and Nuchar SA exhibit bidendate surface complexes. Other solids, however, form only monodendate surface complexes. It is noted that TiO2, SiO2 and Nuchar SA are strong solid acids. The presence of ligand can affect the adsorption of metal ions. Increasing the concentration of complexing ligand tends to inhibit the adsorption of metal complexes. Competitive adsorption between the 'free' ligand and the complexed metal ions can inhibit the adsorption of the metal complexes. (See also W90-04370) (VerNooy-PTT)
W90-04383

MECHANISMS OF METAL ION ADSORPTION ON ACTIVATED ALUMINA.
Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.
For primary bibliographic entry see Field 5F.
W90-04384

CATION EXCHANGE REMOVAL OF HEAVY METALS WITH A RECOVERABLE CHELANT REGENERANT.
Purdue Univ., Lafayette, IN.
J. E. Etzel, and D. H. Tseng.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 571-585, 1 fig, 5 tab, 7 ref.

Descriptors: *Cation exchange, *Heavy metals, *Chelating agents, *Metal-finishing wastes, *Waste recovery, *Wastewater treatment, Resins, Chemical precipitation, Copper, Zinc, Nickel, Regeneration, Ion exchange.

There is a need for effective removal of heavy metals from metal plating and finishing wastewaters. Ion exchange studies showed that the sodium salt of ethylenediamine tetracetic acid (EDTA), nitrilotriacetic acid (NTA), or citric acid (CIT) could be used to regenerate a strong cation exchanger, exhausted with Cu, Zn, or Ni or a mixture of all three metals. It was found that almost complete regeneration with essentially stoichiometric amounts of chelate could be obtained between pH 6 and 9. Although regeneration effectiveness increased as solution pH increased, formation of metal hydroxides occurred when the pH was greater than 10. The resulting precipitate fouled the resin and reduced exchange ability. Regeneration effectiveness for a Cu, Z, or Ni exhausted exchanger with EDTA, NTA, or CIT was in the order Cu > Zn > Ni. Regeneration effectiveness of EDTA, NTA, and CIT varied as the number of Na ions available for exchange per mole of chelating agent solution. The recovery of both the heavy metal and the chelating agent solution from a spent regenerant was evaluated via an electromembrane process. When a current was applied, the metal was electrodeposited and the metal-chelate complex destroyed. Electrodeposition of Cu and Zn from their chelate complexes was achieved but no electrodeposition of Ni was possible in the presence of EDTA, NTA, or CIT. The higher the initial metal concentration in the spent regenerant, the better the current utilization for a 90% recovery of heavy metal. In evaluation of the cyclic process of regeneration, recovery and chelant reuse, the resin was exhausted with copper, regenerated with EDTA, and the EDTA-Cu recovered by electromembrane deposition. There was no need for additional EDTA during 5 complete cycles. EDTA recovery and Cu recovery averaged about 97%. (See also W90-04370) (VerNooy-PTT)
W90-04386

PURIFYING PLATING BATHS BY CHELATE ION EXCHANGE.
Foster-Miller Associates, Inc., Waltham, MA.
H. Gold, G. Czupryna, R. D. Levy, C. Calmon, and R. L. Gross.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 619-642, 6 fig, 8 tab, 13 ref. Air Force Contract FO8635-83-C-0277.

Descriptors: *Metal-finishing wastes, *Wastewater treatment, *Ion exchange, *Chelating agents, *Heavy metals, Waste recovery, Resins, Nickel, Purification, Metals, Economic evaluation, Operating costs, Wastewater facilities, Pilot plants.

The US Air Force currently performs most of its industrial plating operations at five Air Logistics Centers throughout the US. Ion exchange is one method of purifying their contaminated plating baths for reuse. A laboratory test program was carried out to determine the feasibility of using chelate ion exchange for the purification and reuse of plating baths. Plating baths considered were electroless nickel, electrolytic nickel, nickel strike and hydrochloric acid etch. The best resins for treating each bath were selected, and breakthrough tests were run on plating baths spiked with the contaminant metals. Performance of the best resins was determined in 50 mL burettes and in a 1 inch diameter glass column using representative samples of the actual plating baths. Results of the pilot scale test program have shown that chelate ion exchange is an economically viable process for the purification and reuse of contaminated plating baths. Removal of contaminant metals from plating and etching baths extend the operating life of the baths and reduce the costs (and the risks) associated with the replacement and disposal of the spent baths. The exceptionally short payback period of 5 months is the result of the high value of the plating baths. Treatment by chelate ion exchange was shown to be suitable for the four plating etching baths studied. (See also W90-04370) (VerNooy-PTT)
W90-04387

HEAVY METALS REMOVAL: PILOT SCALE RESEARCH ON THE ADVANCED MEXICO PRECIPITATION PROCESS.
Istituto di Ricerca sulle Acque, Rome (Italy).
G. Tiravanti, A. C. Di Pinto, G. Macchi, D. Marani, and M. Santori.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 665-682, 10 fig, 6 tab, 22 ref.

Descriptors: *Chemical precipitation, *Wastewater treatment, *Heavy metals, *Mercury, *Waste recovery, Chemical treatment, Separation techniques, Effluents, Pilot plants, Sludge drying, Economic evaluation.

Results obtained in the development of a precipitation process based on Metals Extraction by Xanthate Insolubilization and Chemical Oxidation (MEXICO) are described. This process, utilizing either water soluble starch xanthate or insoluble cellulose xanthate, is able to lower the effluent metals concentration down to microgram/L levels for most of the heavy metals (Hg, Cu, Cd, Ag). The mercury precipitation process has been thoroughly studied both in batch and continuous tests, and an effect of the metal speciation on the process kinetics has been seen. Results obtained from continuous pilot plant (15 cu m/day) tests with simulated and real chloralkali wastewaters are presented. High metal content (10 to 20% dry weight) is reached in the sludge produced, which is easily dewatered. An oxidizing treatment of the sludge with NaClO allows the metal recovery in concentrated solution, leaving a non-toxic solid residue which can be safely disposed. Process applicability to chloralkali wastewaters has been verified by pilot plant tests which provided all data required for a technical-economical evaluation, in comparison with other precipitation processes. (See also W90-04370) (Author's abstract)
W90-04388

ECONOMIC FEASIBILITY OF A STATE-WIDE HYDROMETALLURGICAL RECOVERY FACILITY.
ERM-North Central, Inc., Palatine, IL.
For primary bibliographic entry see Field 5E.
W90-04389

RECOVERY OF ALUMINUM AS ALUMINUM SULFATE FROM ALUMINUM ANODIZING SLUDGE.
Georgia Inst. of Tech., Atlanta.
F. M. Saunders.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 713-726, 5 fig, 2 tab, 6 ref.

Descriptors: *Metal-finishing wastes, *Aluminum, *Waste recovery, *Alum, *Wastewater treatment, *Sludge drying, Chemical sludge, Clarification, Neutralization, Settling velocity, Sludge thickening, Wastewater facilities.

In the aluminum finishing industry, while the persistence and toxic properties of aluminum are of limited concern, aluminum-hydroxide sludges are highly gelatinous and extremely difficult to dewater, and after dewatering contain high levels of moisture. A unique process configuration at an aluminum finishing plant is analyzed. Unconditioned wastewater suspensions were collected from Plant A2 which produced anodized architectural aluminum components. The bulk of the wastewater was rinse water (continuous discharge wastewater), but on a weekly basis, the caustic-soda etching bath and a sulfuric acid anodizing bath were discharged (batch discharge wastewater). Characteristics of the wastewaters are detailed, and zone settling velocities were measured for a broad range of suspended solids concentrations, as well as specific resistance and the associated cake solids values. The application of batch neutralization of spent finishing baths resulted in significant improvements in sludge handling and treatment properties. Batch discharge of spent caustic soda etching and acidic anodizing baths produced a wastewater suspension with the thickening properties, as measured using zone settling velocities, which were as much as 10 to 100 fold higher than those for waste waters produced by neutralization of dilute rinsewaters. This resulted in improved thickening of the composite wastewater and higher influent suspended solids concentrations for the subsequent dewatering system. Sludge watering rates for the batch discharge wastewater were improved. Acidification of dewatered sludge solids resulted in the rapid production of a commercial strength solution of aluminum sulfate (liquid alum). A full-scale reclamation plant has been successfully operated for an 18 months. (See also W90-04370) (VerNooy-PTT)
W90-04390

STUDIES OF THE UPTAKE OF HEAVY METALS BY ACTIVATED SLUDGE.
Metropolitan Sanitary District of Greater Chicago, IL.
G. Elenbogen, B. Sawyer, C. Lue-Hing, K. C. Rao, and D. R. Zenz.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 731-755, 3 fig, 6 tab, 15 ref.

Descriptors: *Activated sludge process, *Heavy metals, *Sludge utilization, *Wastewater treatment, *Cadmium, Municipal wastes, Digested

sludge, Separation techniques, Pilot plants, Retention time, Aeration.

The majority of sludge produced at the Metropolitan Sanitary District of Greater Chicago treatment facilities is composed of waste activated sludge from the activated sludge process. Any reduction in the metal concentrations in waste activated sludge would have a significant impact on metal concentrations in the digested sludges used for land application. A study was conducted to determine whether an operational change, not requiring significant capital expenditures, could be made in the wastewater treatment process in order to control or reduce metals uptake by activated sludge solids while maintaining effluent metals concentrations consistent with permit limitations. A pilot plant study was conducted, consisting of operating two activated sludge units simultaneously, with only different sludge retention times (SRT; 3 days and 10 days) and the resultant mixed liquor suspended solid (MLSS) levels. No correlation between SRT and metal uptake was found. Laboratory scale batch aeration systems were also set up to study the uptake of Cd by mixed liquor in a more controlled manner. Fresh samples of return sludge and preliminary effluent were collected and blended from mixed liquors to the desired solids concentrations. When mixed liquor samples were spiked with soluble Cd (added as CdCl2) in order to raise the Cd content of the system, the uptake of soluble Cd was rapid, with more than 90% of influent cadmium being adsorbed within a few minutes of contact. At MLSS to Cd ratios greater than 1,000:1, almost instantaneous adsorption of soluble Cd occurs at initial concentrations of up to 10 mg/L. Even with the high adsorptive capacity of mixed liquor solids at the sewage treatment works, influent soluble Cd concentrations greater than 2.0 mg/L, at MLSS:Cd ratios of less than 500:1, could possibly cause effluent Cd concentrations to exceed 0.15 mg/L, which is the current effluent limit. (See also W90-04370) (VerNooy-PTT)
W90-04391

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT: MUNICIPAL, INDUSTRIAL AND AGRICULTURAL.
Proceedings from the First International Conference on Constructed Wetlands for Wastewater Treatment held in Chattanooga, Tennessee on June 13-17, 1988. Lewis Publishers, Chelsea, Michigan. 1989. Edited by Donald A. Hammer. 831p.

Descriptors: *Wetlands, *Land disposal, *Conferences, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Municipal wastewater, Industrial wastewater, Agricultural wastewater, Tennessee.

Widespread use of constructed wetlands may provide a relatively simple and inexpensive solution for controlling many water pollution problems facing small communities, industries, and agricultural operations. Adoption of this technology has been inhibited by a lack of guidelines and instructions supported by adequate information on important system components and basic wetlands ecology. The goal of the present volume is to provide information to improve acceptance and increase application of constructed wetlands for water quality improvements. The book represents the proceedings of the First International Conference on Constructed Wetlands for Wastewater Treatment, held at Chattanooga, Tennessee, on 13-17 June 1988. Besides wetlands treatment of municipal wastewater, which has been the subject of other conferences, this volume includes applications with acid mine drainage, urban runoff, agricultural wastes, and industrial effluents. Topics include: general principles (hydrology, chemistry, physics, ecology, and microbiology); case histories (pilot and full-scale plants); design, construction, and operation; and recent results from field and laboratory (dynamics of inorganic and organic materials in wetlands, efficiencies of substrates, vegetation, water levels, and microbial populations, management of domestic and municipal wastewaters, nonpoint source pollutants (urban runoff and agricultural wastes), applications to industrial and landfill wastewaters, and control of acid mine drainage including coal pile and ash pond seepage). (See W90-04393 thru W90-04476) (Rochester-PTT)
W90-04392

WASTEWATERS: A PERSPECTIVE.
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 5G.
W90-04393

WETLANDS ECOSYSTEMS: NATURAL WATER PURIFIERS.
Tennessee Valley Authority, Knoxville. Waste Technology Program.
D. A. Hammer, and R. K. Bastian.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 5-19, 5 fig, 17 ref.

Descriptors: *Wetlands, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Ecosystems, Cost analysis, Comparison studies, Reviews.

Constructed wetlands are defined as a designed and man-made complex of saturated substrates, emergent and submergent vegetation, animal life, and water that simulates natural wetlands for human use and benefits. Synonymous terms are man-made, engineered, or artificial wetlands. Most constructed wetlands used in wastewater treatment emulate marshes. Constructed wetland systems (1) are relatively inexpensive to construct and operate; (2) are easy to maintain; (3) provide effective and reliable wastewater treatment; (4) are relatively tolerant of fluctuating hydrologic and contaminant loading rates; and (5) may provide indirect benefit such as green space, wildlife habitats, and recreational areas. Disadvantages of constructed wetlands for wastewater treatment relative to conventional systems include: (1) relatively large land area requirements for advanced treatment; (2) currently imprecise design and operating criteria; (3) biological and hydrological complexity and a lack of understanding of important process dynamics; and (4) possible problems with pests. Furthermore, operation of constructed wetland systems may require two or three growing seasons before optimal efficiencies are achieved. Probably the greatest single problem is the lack of detailed information from long-term experience with these systems. Although research and demonstration projects have shown that wetlands can provide effective treatment, this treatment option remains generally unknown outside the scientific community. (See also W90-04392) (Rochester-PTT)
W90-04394

HYDROLOGIC FACTORS IN WETLAND WATER TREATMENT.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
R. H. Kadlec.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 21-40, 16 fig, 3 tab, 24 ref.

Descriptors: *Land disposal, *Wetlands, *Wastewater treatment, *Artificial wetlands, *Wetland hydrology, Biological wastewater treatment, Water pollution control, Macrophytes, Evapotranspiration, Overland flow, Seasonal distribution, Retention time, Rainfall, Performance evaluation.

A wide variety of wastewaters have been treated with wetland systems and most have been successful. Three features distinguish wetland treatment systems from conventional concrete and steel wastewater facilities: (1) wetland systems interact strongly with the atmosphere via rainfall and evapotranspiration; (2) plants influence water movement, both overland flow and evapotranspiration; and (3) because contact times are long with respect to the time scales of rainfall and microbial dynamics, but short with respect to seasonal processes, the operation of these systems may not be viewed as a steady-state process. Current information on key hydrologic processes in wetlands is reviewed here and their implications for process performance are considered. Topics include: flow resistance, evaporation and transpiration, atmospheric augmentation, water quality consequences. In design of wetlands for wastewater treatment, it is not safe to ignore water exchanges with the atmosphere, because they can significantly contribute to total water flow. Rainfall causes two opposing effects: (1) dilution of wastewater, reducing concentrations, and (2) increased velocities, reducing retention times within the wetland. The result will be reduced exit concentrations, which can be interpreted as erroneously high rate constants for the process. The impacts of evaporative processes on a wetland treatment system are not trivial. Even in northern climates, all applied wastewater can be evaporated during a dry summer season, as occurred twice in 10 yr in one system. A wetland system designed without regard for atmospheric augmentation may be under-designed or overdesigned, depending on the degree of treatment and local conditions of water gains or losses. Frictional effects associated with water flow through a gravel or rock substrate differ from flow through stems and litter above ground. With sand and gravel, system overloads can cause emergent overland flow near the entrance, whereas with stems and litter, high vegetation densities can increase depths above planned weir settings. Both effects are forms of water mounding. (See also W90-04392) (Rochester-PTT)
W90-04395

PHYSICAL AND CHEMICAL CHARACTERISTICS OF FRESHWATER WETLAND SOILS.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2H.
W90-04396

WETLAND VEGETATION.
Louisiana State Univ., Baton Rouge. Dept. of Botany.
G. R. Guntenspergen, F. Stearns, and J. A. Kadlec.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 73-88, 1 tab, 104 ref. NSF Grant BSR-8604556.

Descriptors: *Wetlands, *Aquatic plants, *Soil-water-plant relationships, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Rhizosphere.

Natural wetlands have been used to treat wastewater with varying efficiency. Concern over environmental impacts on natural systems and the need for an empirically-based wetlands wastewater treatment technology led to emphasis on constructed wetlands. Wetland vegetation is reviewed, including: classification, adaptations of plants to the aquatic environment, production and growth, nutrient uptake, adaptations to anaerobic conditions, factors limiting plant growth, and vegetation interactions with wastewater. Over 1000 species of plants have been found that are from entirely aquatic plant families, yet less than 1% of the available taxa have been tried in wastewater treatment projects. Emergent and floating-leaved species have been used preferentially in pilot studies of constructed wetlands. Floating-leaved species have been used because of their high growth rates, large standing crops, and ability to strip nutrients directly from the water column. Potentially useful emergent species include many members of the cattail, reed, rush, sedge, and grass families. Phalaris, Spartina, Carex, and Juncus all have potentially high uptake and production rates. They are widespread, able to tolerate a range of environmental conditions, and can alter their environment in ways suitable for wastewater treatment. Rhizosphere processes are largely unknown, but presumably have positive impacts (e.g., through oxygenation). Submerged aquatic plants do not appear to have attributes useful in wastewater treatment. They have low production rates and many species

are intolerant of eutrophic conditions and/or have detrimental interactions with algae in the water column. However, some species do possess large surface areas, oxygenate the rhizosphere, and are adapted to eutrophic disturbed systems. Submergents may be useful in conjunction with other species. Because different types of wastewater treatment (e.g., municipal, stormwater, acid mine drainage) have different treatment needs, one plant species or set of species will not be applicable in all cases. (See also W90-04392) (Rochester-PTT)
W90-04397

WETLANDS MICROBIOLOGY: FORM, FUNCTION, PROCESSES.
Istituto di Ricerca sulle Acque, Rome (Italy).
R. J. Portier, and S. J. Palmer.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 89-105, 4 fig, 2 tab, 37 ref.

Descriptors: *Land disposal, *Wetlands, *Artificial wetlands, *Microorganisms, *Cycling nutrients, *Wastewater treatment, Biological wastewater treatment, Water pollution control, Organic matter, Biodegradation.

Microorganisms have a substantial role in transformation of organic and inorganic substances critical to all life on earth. Microbial processes are reviewed in relation to the use of constructed wetlands for wastewater treatment, with emphasis on bacteria, but with information included on fungi and actinomycetes as well. Topics include: microbial forms, microbial functions, habitat requirements within constructed wetlands (temperature, pH, salt concentration); reproduction of bacteria and population growth; kinetics of microbial growth, geochemical influences of microbial processes in wetlands (metals requirements and metals toxicity, metal toxicity resistance, and accumulation of heavy metals), and implications of anthropogenic organics (petroleum aromatic hydrocarbons and aromatic and aliphatic hydrocarbons in constructed wetlands). The most important parameter for aquatic microorganisms is nutrient availability. Most aquatic environments are oligotrophic (starvation conditions) and their inhabitants must cope with uncertain, often unsuitable conditions for survival. Below threshold concentration, onset of starvation survival is characterized by bacterial division without concurrent growth to produce ultramicrocells. The complexity and diversity of aquatic microorganisms and their environments makes it virtually impossible for optimal conditions to exist for each organism. At any one time, most microbes are surrounded by waters lacking sufficient nutrients from which ATP can be produced, that is, lacking sufficient energy-yielding substrates. Biodegradable organics are the energy-yielding substrates for heterotrophic bacteria. Many microorganisms can become dormant (up to many years) waiting until external conditions improve. Microbes can be considered living catalysts, converting dissolved organic carbon to particulate organic carbon suitable for higher-order consumers. As the base of the food web, microbes facilitate the flow of organics through the system. By increasing efficiency, microbes affect the rate of carbon cycling through the system. As catalysts, they are the central focus of biological treatment within a constructed wetlands system. (See also W90-04392) (Rochester-PTT)
W90-04398

WETLANDS: THE LIFEBLOOD OF WILDLIFE.
National Wildlife Federation, Washington, DC. Fisheries and Wildlife Div.
For primary bibliographic entry see Field 2H.
W90-04399

CONSTRUCTED FREE SURFACE WETLANDS TO TREAT AND RECEIVE WASTEWATER: PILOT PROJECT TO FULL SCALE.
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
R. A. Gearheart, F. Klopp, and G. Allen.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 121-137, 8 fig, 5 tab, 22 ref.

Descriptors: *Land disposal, *Wetlands, *California, *Wastewater treatment, *Artificial wetlands, Biological pilot plants, Water pollution control, Macrophytes, Biochemical oxygen demand, Suspended solids, Dissolved oxygen, Performance evaluation, Fecal coliforms.

Four years of pilot studies and two years of full-scale operation have been completed with a constructed freshwater wetlands treatment system for polishing secondary-treated wastewater at Arcata, California. The first pilot study involved 12 experimental wetlands receiving oxidation pond effluent at hydraulic loadings of 0.02 to 0.24 cu m/sq m daily. The second pilot study involved 10 experimental cells that were operated at variable depths and hydraulic loadings and with various harvesting techniques applied. The full-scale plant employed a primary digester with cogeneration capability, cellularized oxidation ponds (2.3 ha of treatment wetlands), a chlorination/dechlorination facility, and 13.6 ha of effluent polishing wetlands. In the three different projects, reductions in BOD5 were 56%, 73%, and 55%, to final values of 11.4, 13.8, and 12.0 mg/L, respectively. Suspended solids (SS) were reduced 85%, 80%, and 54%, respectively, to effluent values of 5.3, 10.8, and 14.0 mg/L, respectively. Dissolved oxygen was reduced 73%, 76%, and 27%, respectively, to final output values of 1.5, 1.1, and 5.0 mg/L. The use of 375-sq m pilot cells was effective in predicting the behavior of the larger scaled wetland systems. BOD5 and fecal coliform removal can be modeled effectively by first-order kinetics. Effluent BOD5 from a wetland is a function of organic loading rates, whereas SS effluent level is a function of some minimal detention time. Wetland treatment systems are effective and reliable for treating oxidation pone effluent to 30 mg/L BOD5 and SS standard and can be designed and operated to produce 10 mg/L BOD5 and SS effluents. (See also W90-04392) (Rochester-PTT)
W90-04400

ISELIN MARSH POND MEADOW.
Indiana Univ. of Pennsylvania.
T. E. Conway, and J. M. Murtha.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 139-144, 1 fig, 6 ref.

Descriptors: *Wetlands, *Land disposal, *Pennsylvania, *Wastewater treatment, *Artificial wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Rural areas, Fish ponds, Cattails, Duckweed, Reed canary grass, Biological oxygen demand, Suspended solids, Performance evaluation, Coliforms.

The Iselin Marsh Pond Meadow project was conducted in Indiana County, Pennsylvania, to examine the feasibility of a wetlands type wastewater treatment system for small towns. The capital cost of the system was $350,000. The system was designed serve an average daily flow of 45 cu m/day from 62 houses and consisted of the following elements: (1) a small comminutor and bar screen, (2) an aeration cell with a floating surface aerator, (3) a lateral-flow marsh with cattails (Typha latifolia) in a sand medium, (4) a facultative pond with mixed plants (Lemna, Sagittaria, Nuphar, and Amacharis) and fish (Cyprinus carpio, Ictalurus nebulosis, and Lepomis) to remove the plants, (5) a meadow planted with reed canary grass (Phalaris arundinacea) to provide final filtration, treatment, and nutrient uptake, (6) a concrete trough to collect and discharge the treated effluent, and (7) an erosion chlorinator and contact tank (120 min) to control bacteria. The start-up date was February 1983. The system was capable of exceeding secondary discharge requirements of 30 mg/L suspended solids, 30 mg/L BOD5, and effective disinfection. Average yearly reductions of suspended solids were 89% and BOD5 were 97%, with yearly fecal coliform reduction exceeding 99%. These three parameters did not change significantly seasonally but the effectiveness of the system in reducing ammonia N and total P varied between summer and winter conditions. Several physical modifications of the system have been made based on operational experience and seven similar or modified systems are under development in Pennsylvania. (See also W90-04392) (Rochester-PTT)
W90-04401

INTEGRATED WASTEWATER TREATMENT USING ARTIFICIAL WETLANDS: A GRAVEL MARSH CASE STUDY.
San Diego State Univ., CA. Graduate School of Public Health.
R. M. Gersberg, S. R. Lyon, R. Brenner, and B. V. Elkins.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 145-152, 2 fig, 1 tab, 19 ref. California Department of Water Resources Grant B-54835, EPA Grant CR 807299-01-1.

Descriptors: *Land disposal, *Wetlands, *Wastewater treatment, *Artificial wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Nitrogen removal, Coliforms, Biological oxygen demand, Suspended solids, Bulrushes, Ammonia, Reeds, Cattails, Bacteria, Performance evaluation.

Tests of the use of artificial wetlands for performing secondary treatment of municipal wastewaters and the mechanisms of nitrogen and total coliform removal were examined. The test system consisted of beds containing aquatic plants growing in gravel. In the larger artificial wetland (Scirpus cover) at an application rate of about 5 cm/day (7.5-8 ha per 3785 cu m/day), the mean BOD5 removal efficiency for an October to August period was 90%, with the mean effluent level of 113 mg/L reduced to 11 mg/L in the wetland effluent. On four sampling dates in the winter, effluent BOD5 exceeded 30 mg/L. The wetlands also removed about 90% of the influent suspended solids (70 mg/L reduced to 6.8 mg/L). Capital costs for a facility capable of treating 3785 cu m/day (1 mgd) is estimated at $1.7 million compared to $2.5 million for an equivalent conventional secondary treatment facility. Estimated operation and maintenance expense of $137 per 3785 cu m treated is less than half the corresponding cost for conventional secondary treatment. Ammonia removal rates of 94% were measured for bulrush, 78% of reeds, and 28% for cattails, compared to 11% for an unvegetated bed. It is suggested that nitrifying bacteria can be stimulated by the oxidizing abilities of the plant rhizome, which performs a function analogous to that of an air compressor in an activated sludge tank. The ability of artificial wetlands to perform integrated wastewater treatment by removing bacterial indicators as well as BOD5, suspended solids, and nitrogen makes them an attractive alternative for meeting treatment needs of small-to-medium-sized communities. Where land is available, artificial wetlands offer a simple process design, lower operating and maintenance expense, and wildlife enhancement value, and represent an innovative solution to cost-effective wastewater treatment. (See also W90-04392) (Rochester-PTT)
W90-04402

SEWAGE TREATMENT BY REED BED SYSTEMS: THE PRESENT SITUATION IN THE UNITED KINGDOM.
Water Research Centre, Stevenage (England).
P. F. Cooper, and J. A. Hobson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 153-171, 7 fig, 4 tab, 9 ref.

Descriptors: *United Kingdom, *Reed bed treatment systems, *Wetlands, *Land disposal, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Reeds, Municipal wastes, Performance evaluation, Comparison studies, Seasonal variation.

Reed bed treatment systems (RBTS) are methods of sewage treatment in an artificial (constructed)

wetland containing common reeds (Phragmites australis). The system depends on the flow of sewage through a bed of soil or gravel in which the reeds are growing. RBTS in the United Kingdom and Europe are described, including design and construction details (bed size and shape, growth medium, plants and planting, weed control, feed distribution, outlet collector, and liner); performance of full-scale beds (Gravesend, Marnhull, Holtby, Castleroe, Middleton, Valleyfield, and Little Stretton); and small-scale tests in mobile test tanks. Data from most United Kingdom RBTS with full sampling and analysis are encouraging, particularly considering that none of the systems has reached maturity (3-5 yr). Reeds grow well in gravel, but most treatment observed so far is likely due to physical filtration. Some systems built in soil have suffered from overland flow and excessive weed growth. Performance of the Holtby, Marnhull, and Middleton soil beds is quite encouraging, however. The small beds are providing useful information, but its representativeness is unknown until more results from larger-scale RBTS are analyzed. Effluent quality appears to deteriorate slightly in winter (December-March), a phenomenon observed in the full-scale beds. Moving and/or draining the small-scale beds may have an adverse effect on treatment performance. (See also W90-04392) (Rochester-PTT)
W90-04403

AQUATIC PLANT/MICROBIAL FILTERS FOR TREATING SEPTIC TANK EFFLUENT.
National Aeronautics and Space Administration, Bay Saint Louis, MS. John C. Stennis Space Center.
B. C. Wolverton.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 173-178, 2 fig, 1 tab, 10 ref.

Descriptors: *Wetlands, *Land disposal, *Mississippi, *Wastewater treatment, *Artificial wetlands, Septic tanks, Biological wastewater treatment, Water pollution control, Aquatic plants, Performance evaluation, Rural areas.

The use of natural biological processes for treating various types of wastewater has been developed at the John C. Stennis Space Center during the past 15 yr. The design and operating experience with some of these systems at various locations in Mississippi is described. Septic tank effluent from single homes can be treated to advanced secondary levels or better using a 400-sq ft washed gravel filter. The filter should be 1.0-1.5 ft deep, with the wastewater level maintained at 6 in below the rock surface. When ornamental plants (e.g., calla lily, Zantedeschia aethiopica, canna lily, Canna flaccida, elephant ears, Colocasia esculenta, yellow iris, Iris pseudacorus, and ginger lily, Hedychium coronarium) are planted in the rock filter, their roots penetrate to the wastewater level, adding oxygen and increasing biological activity. If a point-source discharge is not desired, approximately 20 ft of 4-in perforated leach field tubing is used to disperse the effluent from the rock/plant filter beneath the soil. Large septic tanks use in small towns and communities in lieu of open sewage lagoons have many advantages over open lagoon systems. Several tanks in different locations can discharge their effluent to one or more rock/plant filters for further treatment. Size of the rock/plant filter is dictated by the volume of septic tank effluent and the level of treatment desired. When these systems are properly installed, sewage will not be exposed to the air before treatment has been accomplished. (See also W90-04392) (Rochester-PTT)
W90-04404

CREATION AND MANAGEMENT OF WETLANDS USING MUNICIPAL WASTEWATER IN NORTHERN ARIZONA: A STATUS REPORT.
Apache-Sitgreaves National Forests, Lakeside, AZ.
M. Wilhelm, S. R. Lawry, and D. D. Hardy.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 179-185, 2 tab, 7 ref.

Descriptors: *Wetlands, *Land disposal, *Forest management, *Arizona, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Forages, Elk, Performance evaluation, Seasonal distribution.

The Apache-Sitgreaves National Forests, on the Mogollon Rim in northeastern Arizona, have been the subject of a 10-yr management plan aimed at improving wildlife and recreational uses. The Wetlands Management Program raised ducklings hatched from 9 in 1979 to 2819 in 1982 using a combination of improvements to natural wetlands and creation of new wetlands receiving municipal effluent. The new wetlands provide large evaporation ponds for disposal of wastewater from the city of Show Low, Arizona and for developments known as Pinetop and Lakeside. Marsh disposal for Show Low's secondary-treated effluent cost 32% less than the lowest nonmarsh alternative, and annual operating costs were 47% less with the marsh. Effluent marshes have been an obvious success for wildlife habitat. Several improvements are planned or in progress for this disposal system, including: expansion of effluent production rates from 2200 to 7550 cu m/day for Show Low and 1514 to 9643 for Pinetop-Lakeside by 2025. In addition, effluent storage for winter has been added at Show Low, with a riparian growth area and forage enhancement for wildlife and livestock. At Pinetop and Lakeside developments, a 16-ha storage facility has been added, with flexible water distribution and water level control in the marsh, as well as an overland irrigation area for elk forage. (See also W90-04392) (Rochester-PTT)
W90-04405

LAND TREATMENT OF MUNICIPAL WASTEWATER ON MISSISSIPPI SANDHILL CRANE NATIONAL WILDLIFE REFUGE FOR WETLANDS/CRANE HABITAT ENHANCEMENT: A STATUS REPORT.
Mississippi Sandhill Crane National Wildlife Refuge, Gautier.
J. W. Hardy.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 186-190, 4 ref.

Descriptors: *Wetlands, *Land disposal, *Mississippi, *Wastewater treatment, *Artificial wetlands, *Cranes, Biological wastewater treatment, Water pollution control, Macrophytes, Wildlife management, Wastewater irrigation, Wastewater lagoons, Wastewater disposal, Bermuda grass, Ryegrass.

The Ocean Springs Regional Land Treatment site is located along the northern edge of the Mississippi Sandhill Crane (Grus canadensis pulla) National Wildlife Refuge. The disposal site has two major components: (1) a lagoon system, including facultative lagoon/storage facilities and screening and distribution pump station facilities and (2) a land treatment system, consisting of distribution and sprinkler facilities and underdrain and wetland cell facilities. The treated effluent is pumped to the disposal site and distributed through gun-type sprinklers. An effluent application rate of 0.76 cm/hr is intended to yield zero surface runoff from the 150-ha site. The site has coastal bermuda grass (Cynodon dactylon) with fall overseeding of annual ryegrass (Lolium temulentum) for a potential nitrogen removal capacity of 80-100 kg/ha/yr. Three wetland cells, located 500-1500 m downgrade were constructed to receive underdrain percolate from the treatment site. Spray field operation trials began in January 1986 and became fully operational in October 1987. Several problem areas as well as successes have been noted. Considerable surface runoff of primary treated effluent from one section of the site contaminated and damaged 4-6 km of refuge service roads and ditches. Unseasonably high soil saturation levels curtailed timber harvests. Although normal rainfall restricts woodlands access during rainy periods and causes some roadway erosion, heavy flows from spray field runoff exacerbated these problems. Wetlands operated at less than 25% of predicted efficiency. Major structural erosion problems plagued all three cells. Little percolate reached the cells. The grassland sod in the treatment area may require 3 yr to develop full percolate capacity. However, clearing heavy slash-pine forests and the haying operations in the treatment area resulted in increased crane use. Since 1985, spray fields have become a major feeding area for birds. The success of this cooperative effort in using municipal wastewater for wetlands and sandhill crane habitat enhancement will require several years of evaluation. (See also W90-04392) (Rochester-PTT)
W90-04406

WASTE TREATMENT FOR CONFINED SWINE WITH AN INTEGRATED ARTIFICIAL WETLAND AND AQUACULTURE SYSTEM.
National Fertilizer Development Center, Muscle Shoals, AL.
J. J. Maddox, and J. B. Kingsley.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 191-200, 1 fig, 4 tab, 16 ref.

Descriptors: *Wetlands, *Land disposal, *Farm wastes, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Fish ponds, Water chestnuts, Biomass, Biological oxygen demand, Chemical oxygen demand, Suspended solids, Wastewater irrigation, Performance evaluation.

Livestock waste treatment is described that uses fish culture and sand bed filtration in artificial wetlands to circumvent problems of algae harvesting. Sand beds are planted with Chinese water chestnuts (Eleocharis dulcis) to receive suspended solids and dissolved plant nutrients. A test facility was set up in which a serial water flow was maintained from a groundwater source through a swine manure-fertilized fish culture tank and onto sand filtration beds where water chestnuts were grown. Test tanks were 0.001 ha, 76 cm deep, lined with Hypalon and equipped with PVC plumbing. Tilapia nilotica, silver carp, and bighead carp were stocked at 35,000 fish/ha. Fish wastewater effluent (10-days retention time) was applied to three test sizes of water chestnut sand filtration beds (1.8 sq m, 2.7 sq m, and 4.5 sq m), with irrigation rates equivalent to 60, 100, and 150 L/sq m daily. Net fish production after 160 days of culture was 4300 kg/ha. Flowing water systems produced 31% more when compared with static water trials during the same period. Yields of water chestnuts and hay compared favorably with results obtained in a previous test (1978). Plant response to irrigation rate was correlated linearly with irrigation rates and did not depend on fish pond wastewater retention time. Effective removal rates achieved were 75% for BOD5, 69% for COD, 82% for suspended solids, 74% for fecal coliforms, 66% for total Kjeldahl N, and 66% for total P, compared to the fish pond wastewater source. Water treatment improvements achieved at lower irrigation rates probably are not justified because of reduced yields of water chestnuts. Economic analysis of this type of system must be site specific. Biomass harvesting can provide resource recovery through the production of marketable fish, water chestnuts, and hay. Generally, these systems are cost effective compared with alternative wastewater treatment methods that give comparable water quality results. However, waste treatment is not usually practiced at present and farm experience with these systems is lacking. (See also W90-04392) (Rochester-PTT)
W90-04407

TREATMENT OF ACID DRAINAGE WITH A CONSTRUCTED WETLAND AT THE TENNESSEE VALLEY AUTHORITY 950 COAL MINE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
G. A. Brodie, D. A. Hammer, and D. A. Tomljanovich.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 201-

209, 5 fig, 3 tab, 6 ref.

Descriptors: *Wetlands, *Land disposal, *Alabama, *Wastewater treatment, *Artificial wetlands, Acid mine drainage, Biological wastewater treatment, Water pollution control, Cattails, Woolgrass, Sedimentation basins, Cost analysis, Muskrats, Ecosystems, Invertebrates, Performance evaluation, Heavy metals.

Impoundment 3, a sedimentation basin operated by the Tennessee Valley Authority in Alabama, had had persistent problems with effluent quality compliance, resulting in pollution of Kash Creek. Among the reasons for these problems were inadequate capacity of the basin, variations in flows, influent chemistry, and weather, and vandalism of chemical treatment equipment. A three-cell wetland was conducted to treat the effluent from the 950 coal mine. It included cattails (Typha latifolia) and woolgrass (Scirpus cyperinus) and cost $41,200 to construct and $3,700 for annual operation and maintenance costs. These figures contrasted with $28,500 in annual operating costs over 10 yr for the previous chemical treatment system. Since initial system operation, effluent quality has met permit limits. Generally, the wetland increased pH from 6.1 to 6.9 and reduced total Fe from 14.3 mg/L to 0.8 mg/L, total Mn from 4.8 mg/L to 1.1 mg/L, and total suspended solids from 24 mg/L to 7 mg/L. The number of invertebrate taxa downstream from impoundment 3 in Kash Creek increased from 2 to 19 within six months of wetland construction. The wetlands, which were originally planted with two plant species, contained 20 plant species 13 mo after construction. One observed problem was muskrat burrowing, which caused dike failure and bypass of wetlands water about a year after construction. The dike was repaired and dike slopes were armored with coarse rip-rap from 0.7 m below to 1.0 m above the waterline. (See also W90-04392) (Rochester-PTT)
W90-04408

CONSTRUCTED WETLANDS FOR TREATMENT OF ASH POND SEEPAGE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
G. A. Brodie, D. A. Hammer, and D. A. Tomljanovich.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 211-219, 2 fig, 5 tab, 6 ref.

Descriptors: *Wetlands, *Land disposal, *Heavy metals, *Tennessee, *Alabama, *Wastewater treatment, *Artificial wetlands, Fly ash, Biological wastewater treatment, Water pollution control, Thermal powerplants, Seepage, Manganese, Iron, Cattails, Rushes, Bulrushes, Armyworms, Hydrogen ion concentration, Performance evaluation.

Typically, Tennessee Valley Authority (TVA) ash pond seeps have pH of 3-6, total Fe of 100-200 mg/L and total Mn of 5-10 mg/L, however Fe may be as high as 300-400 mg/L and Mn may be as high as 70-80 mg/L. Widows Creek Steam Plant, Alabama, is a 2000-megawatt station with 129 of retired and 39 ha of active ash pond storage within a 399-ha site. Seepage at one point emanated from a reclaimed ash pond dike and reached Guntersville Reservoir. In April 1986, this seepage was routed through a constructed 0.5-ha wetland with Typha latifolia (cattail) and Juncus effusus (rush) in one cell and cattail and Scirpus cyperinus (bulrush) and some other plants in cells 2 and 3. Fertilizer (Nutra Nuggets) was applied after planting at 6.75 MT/ha and Lorsban was aerially applied to control armyworms (Simyra henrici). At Kingston Steam Plant, Tennessee, a cattail and bulrush marsh (0.9 ha) was established in a similar manner. At Colbert Steam Plant, Alabama, a natural wetland was expanded by construction of dikes (total treatment area 1 ha). Construction costs for three treatment systems ranged from $6.98 to $14.21/sq m of treatment area, whereas typical mine site costs range from $3.58 to 14.12/sq m of treatment area. The wetlands system at Widows Creek removed 97% of the Fe, but only 9% of the Mn, and average discharge pH decreased 2.1 s.u. during the first 8 mo of operation. A drip-feed NaOH system was installed and discharges have met compliance standards since. At Kingston, total Fe was reduced 85%, but there was little Mn removal and pH has consistently dropped 3 s.u. from the influent to the proposed discharge point. Colbert effluent had good pH (6.6), low total Fe (<1 mg/L), but high total Mn (22.5 mg/L) immediately after wetland construction. NaOH treatment was continued to reduce Mn to permit limits. Mn levels within the system have dropped consistently, however, suggesting that the initial high Mn levels resulted from disturbance of previously deposited Mn. (See also W90-04392) (Rochester-PTT)
W90-04409

USE OF WETLANDS FOR TREATMENT OF ENVIRONMENTAL PROBLEMS IN MINING: NON-COAL-MINING APPLICATIONS.
Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.
T. R. Wildeman, and L. S. Laudon.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 221-231, 3 tab, 37 ref.

Descriptors: *Wetlands, *Land disposal, *Mine wastes, *Wastewater treatment, *Artificial wetlands, *Coal mines, *Heavy metals, *Metal mines, Biological wastewater treatment, Water pollution control, Macrophytes, Acid mine drainage, Comparison studies, Sulfates, Pyrite, Ontario, Minnesota, Colorado, Hydrogen ion concentration.

Wetland treatment of environmental problems is used in the coal industry far more than in non-coal mining applications. In coal mining areas, pyrite is the mineral responsible for acid mine drainage problems and it causes most problems in metal mining systems. Fe, Mn, and SO4(2-) dominate the constituents in coal mine drainage, whereas drainages from metal mines is dominated by Cu, Zn, Cd, Pb, and As, as well as Fe, Mn, and SO4(2-). In mining situations where pyrite is absent, water pollution is significantly reduced. With pyrite present, almost every type of heavy metal contaminant may be present in acid drainage from metal mine operations. Acid drainage from metal mines is a more severe problem than that from coal mines because priority pollutants such as As, Cd, Pb, Hg, Cu, and Zn may be present in hazardous concentrations. Low-cost immobilization of pollutants for long periods of time is the goal of using wetlands for mine drainage treatment. Among various possible removal mechanisms, precipitation of metals catalyzed by bacterial activity is postulated as the most likely. Existing metal mine drainage site wetlands can be divided into two types: (1) primary, where the wetland is the only type of treatment in use, and (2) secondary, where the wetland is used as the polishing step. At a tailings site in Sudbury, Ontario, precipitation of oxides appears to be the main removal mechanism in wetlands, with metal uptake by algae secondary. At a taconite mine in northeastern Minnesota, a naturally-occurring white cedar wetland removes 84% of Cu and 92% of Ni, with peat uptake accounting for most of the metal removal. In Montana, effluent from an abandoned lead-zinc mine was reduced in metals by a natural wetland, whereas constructed wetlands did not remove iron or acidity. At Big Five Tunnel, Colorado, mushroom compost had the highest metal removal efficiency and effluent pH compared to peat and limestone rock covered with peat. (See also W90-04392) (Rochester-PTT)
W90-04410

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT AT AMOCO OIL COMPANY'S MANDAN, NORTH DAKOTA REFINERY.
Amoco Oil Refinery, Mandan, ND.
D. K. Litchfield, and D. D. Schatz.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 233-237, 1 fig, 1 tab.

Descriptors: *Wetlands, *Land disposal, *North Dakota, *Oil wastes, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Missouri River, Biological oxygen demand, Suspended solids, Ecosystems, Plants, Animals, Birds.

The Mandan Refinery covers 122 ha on a 389-ha tract of land north of the city of Mandan, North Dakota, along the west bank of the Missouri River. The original wastewater treatment facilities at this site consisted of an American Petroleum Institute (API) oil-water separator as primary treatment and an aerated 6-ha biooxidation lagoon as secondary treatment. The current system adds a cascade of 6 of 11 ponds on the site for an additional treatment area of 6.6 ha. Five more ponds are maintained on the site as wildlife habitat. Sample analyses indicate reductions in concentration of all parameters as the wastewater flows through the treatment system. Reductions of 36-99.9% are obtained in the primary lagoon, and concentrations are further reduced 70-100% in the cascading pond system. Average discharge concentrations into the Missouri River are well below National Pollutant Discharge Elimination System (NPDES) limits, although occasionally the daily limit may be exceeded. In the past 5 yr, only three excursions from the refinery's NPDES permit limits have occurred. These happened during times of heavy rainfall and/or snowmelt and involved excess total suspended solids or BOD. The wetlands support 184 species of plants, several species of (stocked) fish, 191 species of birds, 51 species of which nest in the area, and deer and small mammals. (See also W90-04392) (Rochester-PTT)
W90-04411

UTILIZATION OF ARTIFICIAL MARSHES FOR TREATMENT OF PULP MILL EFFLUENTS.
Weyerhaeuser Co., Tacoma, WA. Technology Center.
R. N. Thut.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 239-244, 4 tab, 8 ref.

Descriptors: *Pulp and paper industry, *Wetlands, *Land disposal, *Industrial wastewater, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Reeds, Cattails, Cordgrass, Hydrogen ion concentration, Temperature, Conductivity, Color, Ammonia, Dissolved oxygen, Performance evaluation, Design criteria.

Treatment of pulp mill effluents was investigated. Eight artificial marshes were constructed in galvanized steel watering troughs, with epoxy-painted interiors to prevent leaching of zinc. A 0.4-m-deep rock substrate was placed in the troughs. The substrate was marl (10-20 mm), a locally abundant rock composed mainly of calcium carbonate and clay. The independent variables considered in the study were presence/absence of plants, plant type, and retention time. The plants tested were cattail (Typha latifolia), reed (Phragmites australis), and cordgrass (Spartina cynosuroides). The experiment was conducted over 3 yr, with most of the studies of independent variables done in the first year and long-term performance evaluated in the second and third years. Four of the eight artificial marshes were left unaltered throughout the experiment, with a retention time adjusted to 15 hr. The other four were reconstructed in various ways in the second year to test the effects of different substrate depths and configurations. The parameters pH, temperature, conductivity, and color did not change appreciably in transit through the marsh systems. The reactors were more effective at 24-hr retention times than at 6-hr retention times, although more pollutant was removed at shorter retention times because more total material passed through the basins. The presence of plants had no substantial effect on removal efficiencies for most pollutants, although plants did enhance the removal of ammonia and phosphorus. Dissolved oxygen and oxidation-reduction potential readings from within the rock substrate indicated an anaerobic, strongly reducing environment. Differences in removal efficiency among the three types of plants were not striking. Removal efficiencies did not

change substantially over the 3-yr study period. Removal efficiencies were a function of retention time in the 6-24 hr range, but the increment of improvement from 15-24 hr was slight. A facility sized for about 15 hr of treatment probably would be adequate for most purposes. At 15 hr, a full-scale artificial marsh at a typical pulp mill in the United States would be 20-40 ha. (See also W90-04392) (Rochester-PTT)
W90-04412

USE OF ARTIFICIAL WETLANDS FOR TREATMENT OF MUNICIPAL SOLID WASTE LANDFILL LEACHATE.
Cornell Univ., Ithaca, NY. Center for Environmental Research.
N. M. Trautmann, J. H. Martin, K. S. Porter, and K. C. Hawk.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 245-251, 2 fig, 10 ref.

Descriptors: *Wetlands, *Land disposal, *Heavy metals, *New York, *Municipal wastes, *Leachates, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Nitrogen removal, Organic matter, Iron, Manganese, Cattails, Bulrushes, Hydraulic conductivity, Performance evaluation.

A potentially cost-effective and energy-efficient prototype system for on-site treatment of landfill leachate has been designed for the town of Fenton, New York. Leachate will be pretreated using overland flow followed by horizontal flow through the root zone in a bed of wetland plants. In the absence of previous experience treating landfill leachate with this technique, its efficacy is not know. Theoretically, overland flow will remove much of the dissolved iron and manganese, readily oxidizable organic matter, ammonia nitrogen, and volatile organics such as benzene. Additional removal of nitrogen and organic matter as well as removal of phosphorus and metal ions will occur in the root-zone bed, producing an effluent that can be discharged directly to surface waters. Through a combination of laboratory studies and evaluation of the prototype system performance, the feasibility of this approach will be determined. Initial laboratory experiments on changes in soil hydraulic conductivity have been conducted. In a 7-month study using Typha glauca Gadr and Scirpus acutus Muhl planted in boxes of sand and grown in a greenhouse, saturated hydraulic conductivity decreased over time in both vegetated and nonvegetated systems, with a significantly greater decrease in the vegetated systems. Saturated hydraulic conductivity declined by 41% in the control systems, probably because of sand settling, and by 55% in the vegetated systems. Ammonia nitrogen and nitrate nitrogen were supplied in ranges of rates comparable to municipal wastewater. Systems with vegetation reduced ammonia nitrogen and nitrate nitrogen concentrations significantly better than those without vegetation. Typha and Scirpus showed comparable rates of nitrogen removal. (See also W90-04392) (Rochester-PTT)
W90-04413

USE OF WETLANDS FOR URBAN STORMWATER MANAGEMENT.
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5G.
W90-04414

USE OF WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT AND DISPOSAL: REGULATORY ISSUES AND EPA POLICIES.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
For primary bibliographic entry see Field 5G.
W90-04415

STATES' ACTIVITIES, ATTITUDES AND POLICIES CONCERNING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Div. of Water Pollution Control, Nashville.
For primary bibliographic entry see Field 5G.
W90-04416

HUMAN PERCEPTION OF UTILIZATION OF WETLANDS FOR WASTE ASSIMILATION, OR HOW DO YOU MAKE A SILK PURSE OUT OF A SOW'S EAR.
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 6B.
W90-04417

PRELIMINARY CONSIDERATIONS REGARDING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Office of Surface Mining Reclamation and Enforcement (DI), Pittsburgh, PA. Eastern Field Operations.
R. K. Wieder, G. Tchobanoglous, and R. W. Tuttle.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 297-305, 1 tab, 24 ref.

Descriptors: *Artificial wetlands, *Land disposal, *Wastewater treatment, *Wetlands, Design criteria, Biological wastewater treatment, Water pollution control, Macrophytes, Cattails, Bulrushes, Sedges, Mosquito control, Harvesting, Spatial variability, Municipal wastewater, Acid mine drainage, Tennessee Valley Authority, Bureau of Mines.

Preliminary design factors are reviewed that are important in considering constructed wetland treatment of municipal wastewaters and of coal mine drainage. Free water surface wetlands with emergent plants used for municipal wastewater treatment consist of basins or channels with a subsurface barrier to prevent seepage; a suitable medium to support emergent vegetation; and water flowing through at a shallow depth. Cattails, bulrushes, and various sedges are used commonly. In subsurface flow systems, unlined or lined trenches or basins are filled with a permeable packing medium, and are planted with emergent plants, including cattails, bulrushes, native sedges, and other local species. The root-zone method and rock-reed-filter are the two principal categories of subsurface flow systems. Although physical design features of wetland treatment systems are site-specific, three general features should be incorporated into the design of any wetland treatment system: (1) division into segments; (2) provision for step-feeding of the influent wastewater; and (3) provision for effluent recycling. Two operational considerations associated with wetlands for wastewater treatment are mosquito control and plant harvesting. Considerable site-to-site variability exists in apparent water quality improvement among wetlands constructed for mine drainage treatment. Two key topics in this field are the area of wetland needed for a particular flow and chemistry of mine drainage, and the cost of wetland treatment relative to more conventional chemical treatment. A comparison between the Bureau of Mines (BOM) 'rule of thumb' for wetland sizing and the Tennessee Valley Authority (TVA) recommendations suggests that the latter, which yields wetlands 2-74 times larger, tend to be less likely to fail to improve water quality. However, reported construction costs are more for the wetlands designed with the TVA method. If properly designed, installed, and managed, constructed wetlands can introduce an important functional and aesthetic element into the landscape. (See also W90-04392) (Rochester-PTT)
W90-04418

SELECTION AND EVALUATION OF SITES FOR CONSTRUCTED WASTEWATER TREATMENT WETLANDS.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
G. A. Brodie.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 307-317, 2 fig, 13 ref.

Descriptors: *Site selection, *Land disposal, *Wastewater treatment, *Wetlands, *Artificial wetlands, Design criteria, Data interpretation, Data acquisition, Surveys, Macrophytes, Spatial variability, Aerial photography, Remote sensing.

Constructed wetlands are practical alternatives to conventional treatment of domestic and municipal sewage, industrial and agricultural wastes, stormwater runoff, and acid mine drainage. Siting a constructed wetland is often dictated by the location of the wastewater source (eg, a public sewage treatment works or an acidic seep at a coal mine). The wastewater source seldom can be relocated, thus forcing the wetland to be located nearby, often at a mediocre or poor site. Nevertheless, siting can be optimized through a comprehensive site investigation process, including site selection, temporary or permanent engineered works design, environmental effects analyses, construction evaluation, remedial works design and construction, and operational and safety checks. Site selection is based on geological, geotechnical, hydrological, and other environmental information that could affect construction, performance, and effects of a wetlands treatment system. Site selection is constrained by the availability of a suitable site and geotechnical merits, eg, well-developed soils, good access, or low flood potential. Despite these constraints, idealized site selection considerations and investigative techniques can be described. A methodology for selecting and evaluating sites for constructed wetlands is presented here in the form of a flow chart. Major steps include: deciding whether or not to use wetland treatment, a preliminary office study with published materials, preliminary design, air photo interpretation, field survey, refined design, data collection (limited or detailed, as needed), data evaluation, final wetland design, pilot testing, design modifications, and, ultimately, construction. Site selection and evaluation should be tailored to the degree of complexity and magnitude of the project. Limited site evaluation followed by a design based on an excessive safety factor is generally wasteful and imprudent. Conversely, conducting a detailed site investigation is unnecessary for siting a small wetland. Regardless of the site-selection methodology employed, a 'walkover' survey is necessary for assessment of candidate sites. This survey should include site inspection and local inquiries. Data from earlier surveys should be confirmed during the site visit. (See also W90-04392) (Rochester-PTT)
W90-04419

PERFORMANCE EXPECTATIONS AND LOADING RATES FOR CONSTRUCTED WETLANDS.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
J. T. Watson, S. C. Reed, R. H. Kadlec, R. L. Knight, and A. E. Whitehouse.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 319-351, 7 tab, 73 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Wastewater treatment, *Wetlands, Design criteria, Acid mine drainage, Municipal wastewater, Biological wastewater treatment, Water pollution control, Macrophytes, Hydraulic loading, Biological oxygen demand, Suspended solids, Nitrogen, Phosphorus, Optimization.

Constructed wetlands are emerging as low-cost, easily-operated, efficient alternatives to conventional treatment for a variety of wastewaters. Most common uses are for treatment of municipal wastewaters and acid mine drainage. There are two major types of systems: surface flow systems with vegetation planted in a shallow pool of water, and subsurface flow systems with vegetation in a permeable soil, gravel, or sand, and water levels below the medium surface. Wetland systems are effective on many contaminants, including BOD, suspended solids (SS), N, P, trace metals, trace

organics, and pathogens. The effectiveness is due to the diversity of treatment mechanisms, including sedimentation, filtration, chemical precipitation, and adsorption, microbial interactions with contaminants, and uptake by vegetation. Reductions in BOD5 and SS generally are high, whereas N and P reductions tend to vary on a site-specific basis. Current knowledge is sufficient for design of systems that substantially reduce targeted contaminants but inadequate to optimize the design and operation for consistent compliance. Hydraulic loading factors are the primary design basis for sizing municipal constructed wetlands. Loading rates vary (0.8 to 62 cm/day), indicative of various treatment and project objectives, system types and configurations, and performance levels. Surface flow systems typically are loaded less than subsurface systems. Hydraulic loading rates of 4.7 cm/day for subsurface flow systems and 1.9 cm/day for surface flow systems should treat primary effluent to at least secondary levels if the systems are otherwise properly designed, constructed, and operated. Hydraulic loading rates for acid mine drainage systems range from 0.81 to 8640 cm/day. A rule of thumb of 29.4 cm/day has been suggested. Many reactions responsible for pollutant reductions in wetland treatment systems follow first-order kinetics. This provides the opportunity to provide a credible, scientific design basis for many of the pollutants of interest. (See also W90-04392) (Rochester-PTT)
W90-04420

ANCILLARY BENEFITS OF WETLANDS CONSTRUCTED PRIMARILY FOR WASTEWATER TREATMENT.
Western Illinois Univ., Macomb. Inst. for Environmental Management.
J. H. Sather.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 353-358, 37 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Wastewater treatment, *Wetlands, Design criteria, Wetland Evaluation Technique, Value, Biological wastewater treatment, Water pollution control, Macrophytes, Mammals, Waterfowl, Ecosystems.

Achieving all the benefits of constructed wetlands depends on several factors: (1) species composition and degree of interspersion of the plant communities; (2) location with respect to human population centers; and (3) location with respect to other wetlands. Various species of waterfowl and other wetland-dependent vertebrates are attracted to and supported by constructed wetlands. Except for muskrats and waterfowl, however, little is known concerning the relation between vertebrate community dynamics and hydroperiod, water chemistry, and plant communities of wetlands. Visual-cultural benefits from wetlands construction are related directly to the complexity of the plant communities and their degree of interspersion. From the perspective of ecological energetics, wetlands are visually and educationally unusually rich environments. Ever-increasing numbers of people consider aesthetics to be one of the most valuable benefits of wetlands, but these values are the most difficult to quantify. Development of the Wetland Evaluation Technique (WET), which is based on interpretations of the information found in the scientific literature, revealed significant gaps in our knowledge about functions of wetlands. A literature search for distinguishing features of wetlands revealed significant gaps in knowledge of chemical mass balances. Most recent research on wetland ecosystems has not generated the information about N, P, and heavy metal transformations in wetlands that is necessary to address the water quality role of wetlands. The magnitude of the ancillary benefits realized from wetlands constructed for wastewater treatment will depend primarily on the degree of complexity and the amount of interspersion of the hydrophytic plant communities. Engineering design, therefore, should be sensitive to the hydrologic regime and soil characteristics required to produces these types of plant communities. (See also W90-04392) (Rochester-PTT)
W90-04421

OVERVIEW FROM DUCKS UNLIMITED, INC.
Ducks Unlimited, Inc., Bismarck, ND. Great Plains Regional Office.
R. D. Hoffman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 359-361, 7 ref.

Descriptors: *Land disposal, *Environmental effects, *Habitat restoration, *Wetlands, *Artificial wetlands, *Waterfowl, *Wastewater treatment, Aquatic habitats, Design criteria, Biological wastewater treatment, Water pollution control, Montana, North Dakota, South Dakota, Minnesota, Wetlands America, Financing.

Ducks Unlimited, Inc. (DUI), is aggressively expanding waterfowl habitat work in the United States in a major thrust called Wetlands America, becoming involved through requests of state and federal wildlife management agencies. 'Wetlands America' includes three programs working directly with wetland habitat in the United States: (1) Habitat USA, which works with wildlife management agencies on waterfowl production enhancement projects in Montana, North Dakota, South Dakota, and Minnesota; (2) the Habitat Inventory and Evaluation System, which was developed in conjunction with NASA and uses satellite imagery and DUI expertise to develop a comprehensive inventory of wetlands resources; and (3) the Matching Aid to Restore States' Habitat (MARSH) program, which returns fund-raising income to the state in which it originated for developing waterfowl habitat within that state's boundaries. DUI is interested in all forms of wetland enhancement. Use of sewage effluent in natural or man-made marshes is of interest specifically for the benefits it may generate for waterfowl and other wetland wildlife species. Another important benefit sewage effluent may provide is a stable water supply for wetlands in areas where the water resource is limited. Caution must be exercised, however, because indiscriminate exploitation of natural marshes can lead to their degradation. The addition of sewage effluent to a natural marsh could hasten eutrophication and increase exposure to toxic compounds or elements. Long-term effects on wetland diversity and density of organisms resulting from sewage additions are unknown. (See also W90-04392) (Rochester-PTT)
W90-04422

CONFIGURATION AND SUBSTRATE DESIGN CONSIDERATIONS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
G. R. Steiner, and R. J. Freeman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 363-377, 3 fig, 1 tab, 18 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, Design criteria, Water pollution control, Artificial wetlands, Macrophytes, Surface flow systems, Subsurface flow systems, Nutrient removal, Optimization.

Components of a constructed wetlands treatment system (CWTS) include preliminary/primary treatment units and the constructed wetlands cell(s). The constructed wetlands (CW) includes substrate, vegetation, and biological organisms contained within a physical configuration that can be described as an attached-growth biological filter. Major pollutant removal mechanisms include sedimentation and filtration (physical), precipitation and adsorption (chemical), and bacterial metabolism (biological). A CWTS can be designed to achieve various levels of secondary and advanced level treatment for BOD5, suspended solids, nutrients, pathogens, metals, and other substances. CWTS design considerations are described under the following headings: configuration (preliminary/primary treatment, flow patterns, configuration alternatives (single cells, parallel cells, and serial cells), length-to-width ratio, configuration and surface flow (SF) or subsurface flow (SSF) systems, available land, inlet distribution, and slope) and substrate (vegetation, substrate types, substrate depth and vegetation type, pollutant removal, and liners). The two basic designs for a CW are SF and SSF. A design can incorporate both types. A SF system consists of a cell or cells with wastewater routed at shallow depths over a substrate supporting emergent vegetation. Flow is controlled by the shallow depth, low flow velocity, and the plant stems and litter. A SSF flow system has a cell or cells with wastewater routed through or below the surface of a permeable substrate supporting emergent vegetation. SSF systems have been described as gravel marsh, root-zone, reed bed, rock/plant filter, and gravel-based emergent macrophyte systems. Depending on the specific pollutant removal needs and other factors, a variety of configurations and substrates can be employed in a CW. (See also W90-04392) (Rochester-PTT)
W90-04423

HYDRAULIC DESIGN CONSIDERATIONS AND CONTROL STRUCTURES FOR CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
J. T. Watson, and J. A. Hobson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 379-391, 9 fig, 12 ref.

Descriptors: *Land disposal, *Wetlands, *Wastewater treatment, *Artificial wetlands, *Biological wastewater treatment, *Hydraulic engineering, Design criteria, Water pollution control, Macrophytes, Mathematical equations, Retention time, Surface flow, Subsurface flow systems, Control structures.

All constructed wetlands are attached-growth biological reactors. Performance is based on first-order, plug-flow kinetics. The equation suggests that, as hydraulic residence time increases, effluent concentrations of biodegradable contaminants decrease. Consequently, hydraulic residence time becomes a key design and operational parameter for optimizing the performance of a wetland system. Hydraulic residence time is defined as a direct function of the length in the flow direction, the width of the system perpendicular to the flow direction, the bed porosity as a decimal fraction, and the depth of submergence in meters, divided by the average flow through the system, in cu m/day. Information of these parameters is summarized here; considerations for each parameter are identified that are important in the performance of wetlands systems; and the type and general design of structures needed to establish the hydraulic regime are identified. Information is segregated, where appropriate, for the two major types of wetland systems (conventional wetland with an exposed free surface (surface flow system) and the submerged bed using a permeable substrate (subsurface flow system). Topics covered are: length and width, porosity, depth of submergence, flow, and bed slopes, and control structure designs (flow splitters, inlets and outlets, and dikes). (See also W90-04392) (Rochester-PTT)
W90-04424

CALIFORNIA'S EXPERIENCE WITH MOSQUITOES IN AQUATIC WASTEWATER TREATMENT SYSTEMS.
California State Water Resources Control Board, Sacramento.
C. V. Martin, and B. F. Eldridge.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 393-398, 5 ref.

Descriptors: *Land disposal, *California, *Mosquitoes, *Wastewater treatment, *Wetlands, Design criteria, Biological wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, Water hyacinth, Marshes, Aquatic insects, Insect control.

California State Department of Health Services guidelines for minimizing mosquito production are: (1) ponds must be kept free of vegetation through a regular maintenance program; (2) banks must be steep enough to discourage vegetation along the margins (minimum slope 3:1); and (3) pond depth must exceed 4 ft to discourage emergent plants. This approach has been successful in its aim of mosquito control, but the guidelines clash with the concept of using wetlands for wastewater treatment because vegetation is encouraged in wastewater systems. Factors leading to growth of created wetlands in California and mosquito problems and their possible solutions are discussed. A 10-yr program involving $1 million in research funds and $21 million in a pilot plant (San Diego) has led to the conclusion that water hyacinths (Eichhornia crassipes) can be used to treat wastewater successfully, although questions about mosquito production remain. The solution to the mosquito problem was a combination of engineering modifications and new equipment development. A second pilot study funded by the state was a freshwater marsh at Arcata, California, which is operating as an award-winning treatment system/nature reserve. Wastewater treatment systems using aquatic macrophytes offer numerous advantages for small communities. Although problems with mosquito production have slowed development in California, careful design before construction and monitoring after construction can keep mosquito breeding within acceptable levels. (See also W90-04392) (Rochester-PTT)
W90-04425

CONSTRUCTING THE WASTEWATER TREATMENT WETLAND: SOME FACTORS TO CONSIDER.
Tohoku Univ., Sendai (Japan). Biological Inst.
D. A. Tomljanovich, and O. Perez.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 399-404, 7 ref.

Descriptors: *Artificial wetlands, *Land disposal, *Wastewater treatment, *Wetlands, Design criteria, Biological wastewater treatment, Water pollution control, Macrophytes, Costs, Construction methods, Specifications.

Constructed wetlands for wastewater treatment may range in size from several square meters to several hectares. Design parameters vary with size, site characteristics, hydrologic soil group, pollutant type and loading rate, geographic locale, watershed characteristics, proximity to residential development, and anticipated operation and maintenance requirements. The construction of wastewater treatment wetlands involves: construction plans, preconstruction site activities, cost estimate preparation, construction, inspection, testing, and startup. Construction includes access road building; clearing; dike building; spillway construction; piping and valving; planting; and seeding, liming, fertilizing, and mulching of dikes and disturbed areas. Close communication between owner/operator, designer, and contractor is crucial throughout the process. Correct type and size of heavy equipment is crucial to ensuring cost-effective, proper construction. If the wetland is built on an existing wet area, two bulldozers (and operators) rather than one should be used because one will get mired down and require the other to free it. In most municipal waste treatment wetlands, construction must follow precisely the engineering plan to achieve proper functioning of the system. Permeability specifications must be followed carefully to prevent leakage into or out of the ponds. If native soils are adequate, dozers and sheepsfoot rollers usually are sufficient to achieve desired compaction. Subsurface flow systems dependent on high hydraulic conductivity in the substrate require special provisions to avoid compacting the substrate during construction or planting. Adequate sizing and installation of spillway and discharge pipe are critical to ensuring dike integrity and safe and proper operation of the wetland. In some areas, muskrats and beavers burrow into dikes or obstruct discharge pipes. Acidic drainage can destroy metal tile, pipes, pumps, and valves. Emergent vegetation must be planted with care and proper guidance to ensure plant survival. An initial maintenance program that includes frequent and thorough inspection and immediate correction of problems is critical to ensuring successful operation of wastewater treatment wetlands. (See also W90-04392) (Rochester-PTT)
W90-04426

CONSIDERATIONS AND TECHNIQUES FOR VEGETATION ESTABLISHMENT IN CONSTRUCTED WETLANDS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
H. H. Allen, G. J. Pierce, and R. Van Wormer.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 405-415, 1 fig, 18 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Wetlands, *Artificial wetlands, *Biological wastewater treatment, Design criteria, Water pollution control, Macrophytes, Hydrology, Ecology, Plant physiology, Soil water.

Hydrologic considerations, substrate, and vegetation are the important factors contributing to the diversity of natural wetlands and form the basis for any wetland development protocol. Water depth and frequency or periodicity of flooding are important in determining the plant species appropriate for the constructed system. Many substrates are suitable for wetland establishment. Loamy soils are especially good because they are soft an friable, allowing for easy rhizome and root penetration. Although peaty organic soils support wetland plants, they are not preferred for wetland development. Many wetlands plants (e.g., sago pondweed, muskgrass) are known calciphiles, whereas others (e.g., Sphagnum spp.) are restricted to acidic soils. Site excavation for wetland establishment is likely to expose a subsoil that may not be as conducive to plant growth as the topsoil. Choosing plants for wastewater treatment should emphasize plants that (1) are active vegetative colonizers, with spreading rhizome systems, (2) have considerable biomass or stem densities to achieve maximum translocation of water and assimilation of nutrients, (3) have maximum surface area for microbial populations, (4) have efficient oxygen transport into the anaerobic root zone to facilitate oxidation of reduced toxic metals and support a large rhizosphere, and (5) be a combination of species that will provide coverage over the broadest spread of water depths envisioned for the terrain. Wetland plants can be purchased from nurseries, collected in the wild, or grown for a specific project. Each method has distinct advantages and disadvantages in terms of quality of plant material, availability of plants, and costs. No generalization can be made that would apply to all projects. Establishing vegetation involves planting with a suitable propagule at the appropriate time. Water level is the most critical aspect of plant survival during the first year after planting. Frequently, too much water creates more problems for wetland plants during the first growing season than too little water because plants do not receive adequate oxygen to their roots. (See also W90-04392) (Rochester-PTT)
W90-04427

OPERATIONS OPTIMIZATION.
CH2M Hill, Inc., Portland, OR.
M. A. Girta, and R. L. Knight.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 417-429, 2 tab, 20 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Nutrient removal, *Wastewater treatment, *Wetlands, Design criteria, Optimization, Biological wastewater treatment, Water pollution control, Macrophytes, Process control, Michigan, Houghton Lake, Florida, Water chemistry, Phosphorus, Nitrogen, Acid mine drainage, Performance evaluation.

The most common approach to wetland treatment system design is to characterize influent water chemistry, environmental conditions, and target effluent water chemistry with sufficient accuracy to design for maximum treatment efficiency under 'average' operating conditions. Often, however, the design does not provide sufficient flexibility to respond to deviations from 'average' operating conditions, resulting in systems that appear unmanageable and unreliable. Predictable disturbances in constructed wetlands occur in the following areas: vegetation establishment, microbial flora colonization, and technical system debugging (startup) and extreme precipitation and temperature, vegetative growth/decay, and population composition changes (seasonal). The Houghton Lake, Michigan, system is an example of an early system in which significant design considerations were overlooked. This system has some capacity for long-term nitrogen removal thorough denitrification, but only a finite life-span in terms of phosphorus removal, its primary design function. When the remaining useful life of 20-30 yr, when P concentrations leaving the wetland to Houghton Lake will be nearly as high as levels in secondary wastewater. At the Reedy Creek and Buenaventura Lakes (Florida) systems, the problems highlight the importance of site-specific information for optimizing certain functions in treatment wetlands. Although wetlands have variable P removal potential and infiltrative capacity is site-specific and low in wetlands, the Reedy Creek natural wetland as well as the wetlands at Buenaventura Lakes, Houghton Lake, and Gainesville (cypress domes) all a provide cost-effective alternative for treating BOD5, total suspended solids, and nitrogen. Many of the wetlands constructed to treat high Fe, Mn, and Al concentrations in acidic discharges from mined areas are designed to revert to natural wetlands within 20-50 yr (the expected lifetime of the problem). Operations requirements for these systems have been minimal, but treatment efficiency has varied widely among systems. Designs that adjust for periods of disturbance through operations changes can extend the life and increase the efficiency of new systems. (See also W90-04392) (Rochester-PTT)
W90-04428

PATHOGEN REMOVAL IN CONSTRUCTED WETLANDS.
San Diego State Univ., CA. Graduate School of Public Health.
R. M. Gersberg, R. A. Gearheart, and M. Ives.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 431-445, 5 fig, 4 tab, 42 ref.

Descriptors: *Decontamination, *Land disposal, *Artificial wetlands, *California, *Wastewater treatment, *Wetlands, *Pathogens, Coliforms, Salmonella, Bacteriophage, Viruses, Biological wastewater treatment, Water pollution control, Macrophytes, Fate of pollutants, Public health, Performance evaluation, Municipal wastewater, Bioindicators.

An assessment of human health risks posed by municipal wastewater treatment using constructed wetlands involves delineating pathogen content of inflowing water, degree of removal/inactivation of pathogens in wetland environments, and level of exposure of receptor (human) population to treated wastewaters. The use of constructed wetlands to reduce human health risks associated with bacteria and viruses is reviewed. Data developed from two types of constructed wetland systems, a gravel-based constructed wetlands in Santee, California, and marshes created from excavations in natural soils in Arcata, California, are presented. The overall objectives of these studies were to assess the degree of removal of (1) the conventional indicators of fecal contamination (total and fecal coliforms) and Salmonella and (2) an indicator of viral pollution, MS-2 bacteriophage. Both the Santee and Arcata constructed wetlands were capable of removing bacterial and viral indicators of pollution at efficiencies of 90-99%. Wastewater treatment by constructed wetlands could typically reduce total coliform levels to at or below 1000 total coliform/100 mL standard when treating secondary wastewaters. However, for the treatment of raw or primary wastewaters, further disinfection is neces-

sary after wetland treatment to attain the 1000/100 mL total coliform standard. Constructed wetlands can make important contributions as wastewater treatment systems not only through their ability to reduce bacteria and virus levels, but due to their ability to remove suspended solids and ammonia, both of which interfere with efficient disinfection. It appears that a hydraulic residence times of three to six days, constructed wetlands are at least equivalent and, in most cases, more effective than conventional wastewater treatment systems for the removal of disease-causing bacteria and viruses. (See also W90-04392) (Rochester-PTT)
W90-04429

MONITORING OF CONSTRUCTED WETLANDS FOR WASTEWATER.
Environmental Protection Agency, Athens, GA. Environmental Services Div.
D. B. Hicks, and Q. J. Stober.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 447-455, 17 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Wetlands, *Monitoring, *Artificial wetlands, Performance evaluation, Biological wastewater treatment, Water pollution control, Macrophytes, Management planning, Cost analysis, Ecosystems, Animals, Plants.

Use of constructed wetlands for the disposal and treatment of wastewater is emerging as an alternative to conventional approaches for small communities and industries. Operation and maintenance of any process control system depend on a monitoring plan that provides information for judging the attainment of treatment objectives, performance, efficiency, and the long-term viability of the system. As the complexity of wastes treated by a wetland increases, so do the monitoring requirements, because more variables are introduced which may result in system failure or lead to undesirable side effects. Cost and effort of monitoring increase with chemical complexity of the influent to be treated and ecological diversity of the wetlands to be maintained. Monitoring strategies are presented here in hierarchical orders according to increasing complexity and implementation effort. Topics include: monitoring plan (compliance monitoring, wetlands system performance and treatment efficiency, and monitoring wetland viability and health). An appropriately designed and implemented monitoring plan is essential to the successful management, operation, and maintenance of constructed wetlands for treatment of wastewater. The monitoring plan has numerous components, including clearly stated objectives, technical and management responsibilities, quality assurance procedures, resources, and schedules. Scope of monitoring activities is a function of treatment goals, project benefits, and diversity of plant and animal communities involved in the wetland system. Results of monitoring determine compliance of the wetland discharge with permit limits established by pollution control agencies. Monitoring of the plant and animal communities provides surveillance data necessary to determine health and viability of the wetlands and identify early signs of stress to the aquatic communities of plants and animals. Early detection of a failing wetland system is essential to the operation and maintenance of the treatment system. Engineered wetlands as treatment systems are appealing because of their low costs of construction and simplicity of operation and maintenance needs. However, appropriate monitoring, though it adds costs, is a necessity and must be viewed as a priority over the life of the project. (See also W90-04392) (Rochester-PTT)
W90-04430

DECOMPOSITION IN WASTEWATER WETLANDS.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
R. H. Kadlec.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 459-468, 5 fig, 3 tab, 13 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Wetlands, *Cycling nutrients, *Artificial wetlands, *Biodegradation, Biological wastewater treatment, Water pollution control, Macrophytes, Nitrogen, Phosphorus, Municipal wastewater, Decomposition, Microorganisms.

The rates of key biomass processes and the amounts of nutrients and biomass involved in decomposition in wetlands used for treatment of wastewater have been previously ignored in performance discussions. Although all assimilable constituents are affected by growth, litter fall, litter decomposition, and leaching and mineralization N and P are analyzed as illustrative of the general processes occurring in an unharvested constructed wetland receiving secondary municipal wastewater. The startup phase of a constructed wetland may take several years: 2-3 yr for vegetation establishment and another 2-3 yr to establish the litter-sediment compartment. During this phase, significant nutrient quantities and other biologically active constituents are stored in new live and dead biomass pools. For a wetland of 10 days' detention, a loading of 2.0 cm/day, and 10 mg/L each of N and P, establishment of the biomass pools (2.0% N and 0.4% P) would require 5 yr and use 60% of the applied N and 12% of the applied P. However, other processes, such as microbial denitrification and phosphorus sorption, function in parallel with biomass generation. Competition for nutrients will prolong the startup phase and cause longitudinal stratification of biomass and litter. Such phenomena have been documented and modeled for natural wetland systems. After a stationary state is reached, only the burial component of the biomass contributes to the removal of nutrients. For the preceding example, deposition of 2.5 mm/yr of new soil at 2.0% N and 0.4 % N would account for 1.4% of the N applied and only 0.7% of the applied P. These calculations assume that all of the applied nutrients are available to plants, which is not generally true. It may be concluded that probable startup times for constructed wetlands are 5-10 yr, which exceeds any record of operational experience established for a constructed wetland. Early reports probably are too optimistic because saturable mechanism are operative during startup. It is possible, however, that microbial processes are establishing themselves at the same time that the saturable mechanisms are being depleted because the litter compartment is the locus of attachment for most of the active microorganisms. (See also W90-04392) (Rochester-PTT)
W90-04431

THERMOOSMOTIC AIR TRANSPORT IN AQUATIC PLANTS AFFECTING GROWTH ACTIVITIES AND OXYGEN DIFFUSION IN WETLAND SOILS.
Cologne Univ. (Germany, F.R.). Botanical Inst.
For primary bibliographic entry see Field 2H.
W90-04432

NITRIFICATION AND DENITRIFICATION AT ISELIN MARSH/POND/MEADOW FACILITY.
Moon Township Municipal Authority, Coraopolis, PA.
R. L. Davido, and T. E. Conway.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 477-483, 3 fig, 1 tab, 13 ref.

Descriptors: *Land disposal, *Denitrification, *Nitrification, *Pennsylvania, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, *Nitrogen cycle, Water pollution control, Artificial wetlands, Macrophytes, Rural areas, Performance evaluation, Microorganisms.

The Iselin Marsh/Pond/Meadow (MPM) is an example of an active wetlands system that has proven effective in removing N from wastewater. The Iselin MPM was designed to treat 45,360 L/day from 62 homes in Iselin, a rural mining town in western Pennsylvania. The present study aimed to define zones of nitrification and denitrification within the Iselin MPM to serve as a basis for optimizing removal capacity at this site. The Iselin MPM consists of a comminutor, an aeration basin, two marsh areas, a pond, two meadow areas, and a chlorination chamber. Samples were collected daily from 10 sites throughout the MPM system from August 9-22, 1985. Temperature, pH, and dissolved oxygen varied little throughout the system. Nitrate-N decreased from the influent to postaeration. Because carbon demand is easily met for denitrifiers in the aeration basin (COD > 800 mg/L and a small anoxic zone in the bacterial floc), the decrease in NO3-N during area probably is due to denitrification. Ammonia-N concentrations decreased at all depths across the marsh. This corresponds with an overall NO3-N increase at all depths. Ammonia-N levels are low at the pond surface, but substantial concentrations were present near the bottom. The increase in NH3-N at the pond bottom results from ammonification of decomposing plant material. Ammonia-N concentrations decreased to less than 0.5 mg/L at the meadow surface. Highest concentrations of NH3-N at the meadow bottom near the inlet resulted from decomposing solids that had been deposited in the meadow media. Overall reduction of total Kjeldahl nitrogen (TKN) from marsh influent to meadow effluent was 95%, producing discharge levels of less than 1 mg/L NH3-N and NO3-N. The MPM system also could remove 93% of the average 860 mg/L COD entering the system. The most effective nitrification component is the marsh. Denitrification occurs within the sludge floc and anaerobic microsites throughout the marsh and may occur in the pond sediments. Denitrification appears to be minimal in the upper pond strata and in the meadow. (See also W90-04392) (Rochester-PTT)
W90-04433

DENITRIFICATION IN ARTIFICIAL WETLANDS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Biotechnologie.
E. Stengel, and R. Schultz-Hock.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 484-484, 6 fig, 14 ref.

Descriptors: *Land disposal, *Wastewater treatment, *Wetlands, *Nitrogen cycle, *Denitrification, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Reeds, Microorganisms, Nitrates, Oxygen, Aerobic conditions, Plant physiology, Sediments.

The aeration function of macrophyte horizons with horizontal flow-through was investigated in artificial wetlands. Denitrification in relation to oxygen concentration, organic carbon sources, and temperature, and oxygen conditions in the root horizon are reported. Measurements were performed in outdoor artificial wetlands with U-shaped channels 0.4 m deep, 0.6 m wide, and 16 m long and total surface are of 9.6 sq m. Channels were filled with grave and vegetated beds were dominated by Phragmites australis (shoot densities 350-580/sq m). An unvegetated control was used. Several conclusions could be drawn as a result of these studies: (1) nitrate elimination in artificial wetlands is possible throughout the whole year, when specific conditions are fulfilled (low O2 concentration in the water, available organic carbon); (2) high denitrification rates were verified even at low temperatures; (3) in summer, when oxygen concentration in the inflowing water is low, denitrification occurs in the whole plant bed; (4) observations on oxygen conditions in the root zone did not show addition of oxygen to the through-flowing water; and (5) the concept that particular plant species control oxygen levels in their surroundings in a predictable way has to be further examined and, if true, this concept of 'controlled aeration' should assist in proper use of macrophytes for diverse ecological and technological purposes. (See also W90-04392) (Rochester-PTT)
W90-04434

NITROGEN REMOVAL FROM FRESHWATER WETLANDS: NITRIFICATION-DENITRIFICATION COUPLING POTENTIAL.
Florida Agricultural and Mechanical Univ., Tallahassee. Wetland Ecology Program.
Y.-P. Hsieh, and C. L. Coultas.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 493-500, 5 tab, 17 ref.

Descriptors: *Land disposal, *Denitrification, *Florida, *Wastewater treatment, *Nitrification, *Wetlands, *Nitrogen removal, Ammonium, Biological wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, Nitrogen cycle, Microorganisms, Liming.

Nitrification and denitrification, although two mutually exclusive processes, coexist in many ecosystems. Existence of heterogeneous microsites or layers in soil systems permits coexistence of these processes. The present study surveyed the nitrification-denitrification coupling potential (NDCP) of representative freshwater wetlands in North Florida and relate this potential to wetland soil properties. Four types of freshwater wetlands were studied: savannah, cypress, black gum, and titi swamps. Soils from these four types of wetlands were obtained in the Apalachicola National Forest. Savannahs had the shortest hydroperiod, cypress and black gum swamps the longest, and the hydroperiod in the titi swamp was intermediate. Incubations in argon, under air, and without and without lime were conducted. Nitrification-denitrification coupling was demonstrated in these acidic freshwater wetlands. Nitrification rate on savannah soils, on a volume basis, was much higher than on the other wetlands, indicating that mineral constituents play an important role in nitrification. Liming actually decreased the nitrification in most cases after 7-day preincubation, suggesting that factors other than pH might control nitrification in these soils. A drastic increase in ammonium level after liming occurred during 7-day preincubations rather than during 2-day incubations. Liming might cause reduction of soil microbial population and subsequently increase net mineralization during the preincubation. The nitrification rate reduction induced by liming also contributes to the high level ammonium. Soil organic carbon had little bearing on nitrification and denitrification rates in these soils. The C/N ratio was better correlated with nitrification and denitrification rates. Nitrification rate is, in effect, the limiting factor for removal through denitrification in wetlands. Savannah wetlands are capable of removing 20 ppm NH3-N from and 1700-20,750 L/ha/day of wastewater through nitrification-denitrification and 20 ppm N03-N from 11,500-87,000 L/ha/day of wastewater through denitrification. (See also W90-04392) (Rochester-PTT)
W90-04435

RELATIVE RADIAL OXYGEN LOSS IN FIVE WETLAND PLANTS.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 2H.
W90-04436

POTENTIAL IMPORTANCE OF SULFATE REDUCTION PROCESSES IN WETLANDS CONSTRUCTED TO TREAT MINE DRAINAGE.
Bureau of Mines, Pittsburgh, PA.
R. S. Hedin, R. Hammack, and D. Hyman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 508-514, 3 tab, 12 ref.

Descriptors: *Land disposal, *Biotransformation, *Acid mine drainage, *Sulfate reduction, *Artificial wetlands, *Wastewater treatment, *Wetlands, Dissimilatory sulfate reduction, Biological wastewater treatment, Water pollution control, Anaerobic conditions, Bacteria, Oxidation, Reduction, Design criteria.

The importance of sulfate reduction in natural or constructed wetlands receiving acid mine drainage (AMD) is uncertain because of contradictory findings from different studies. Several research projects are exploring the use of dissimilatory sulfate reduction (DSR) and metal sulfide formation processes for the treatment of coal mine drainage. DSR is accomplished by heterotrophic anaerobic bacteria that, in the absence of oxygen, decompose simple organic compounds using sulfate as the terminal electron acceptor. DSR bacteria are active only under anaerobic conditions. The most common factors limiting DSR in anoxic sediments are availability of suitable organic matter and dissolve sulfate. Metal sulfides can be destroyed by acidic and aerobic conditions. Acidic conditions cause the resolubilization of iron monosulfides (FeS). In most natural systems, extreme acidification of the organic substrate does not occur. The more common cause of sulfide destruction is oxidation. All forms of elemental and reduced sulfur are subject to oxidation under aerobic conditions. Constructed wetlands for AMD have conditions that should promote DSR and the accumulation of iron sulfides. They contain an excess of high-quality organic matter and high concentrations of dissolved sulfate and iron. With proper maintenance, the organic substrate always will be submerged and never be exposed to aerobic conditions. To aid in designing AMD wetlands, the theoretical significance of sulfide formation was evaluated in a hypothetical constructed wetland in which flow of AMD through anoxic substrates is maximized and sulfide oxidation is minimized. On a yearly basis, the wetland receives 2628 kg Fe, 26,280 kg SO4(2-), and 13,140 kg of acidity (CaCO3 equivalent). Complete removal of all the dissolved iron by pyrite formation requires a minimum reduction of 9010 kg of SO4(2-) and oxidation of 2253 kg of C. DSR and FeS formation are biogeochemical processes that could significantly affect mine drainage chemistry. The sizing of wetlands being constructed today is within an order of magnitude of satisfying the theoretical organic needs of such a system. (See also W90-04392) (Rochester-PTT)
W90-04437

EVALUATION OF SPECIFIC MICROBIOLOGICAL ASSAYS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT MANAGEMENT.
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
R. J. Portier.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 515-524, 3 fig, 1 tab, 14 ref. Office of Sea Grant NA 81-AA-D-0046 and Louisiana Board of Regents Contract B20-21.

Descriptors: *Land treatment, *Wastewater treatment, *Enzyme assay, *Louisiana, *Wetlands, *Microbiological studies, In situ tests, Biological wastewater treatment, Estuarine environment, Terrebonne-Timbalier Bay, Barataria Bay, Estuarine sediments, Salinity gradients, Enzymes.

A major difficulty in the assessment of toxic chemical impact in aquatic marine environments is obtaining reproducible, valid field test information. Cost-effective approaches for in situ analyses of related soil/sediment microenvironments are presented for evaluating wastewater impact and effect in constructed wetlands. Comparisons were made with specific enzyme assays and standard microbial diversity tests. Soil and sediment collections were made in the Terrebonne-Timbalier Bay and Barataria Bay drainage basins in Louisiana along a salinity gradient reflecting microenvironments of considerable diversity and biomass. In situ analyses of interrelated soil/sediment microenvironments are relevant to understanding determinants of productivity in aquatic regions or biotreatment efficiency in a constructed wetland. Total microbial biomass, as determined by the luciferin-luciferase method outlined here, is useful in understanding in situ physiological states of naturally occurring microbial assemblages. Furthermore, total microbial biomass and species diversity may serve as valid indices of biodegradable substrate turnover and productivity. Variations in microbial diversity, enzyme activity, microbial ATP, and substrate uptake in ecologically diverse but related soil/sediment microenvironments in coastal wetland systems provide a vehicle for aquatic microenvironment parameter identification and assessment. These variations reflect autochthonous parameters of microbial viability for toxicological studies and characterize land management practices between hydrologically linked localities. Such observations provide a baseline for monitoring possible impact of toxicant runoff and introduce methods for establishing criteria for productivity assessment in constructed wetlands management. (See also W90-04392) (Rochester-PTT)
W90-04438

SECONDARY TREATMENT OF DOMESTIC WASTEWATER USING FLOATING AND EMERGENT MACROPHYTES.
Reedy Creek Utilities Co., Inc., Lake Buena Vista, FL.
T. A. DeBusk, P. S. Burgoon, and K. R. Reddy.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 525-529, 1 fig, 1 tab, 5 ref. Gas Research Institute (Chicago) Contract 5082-223-0762.

Descriptors: *Wastewater treatment, *Wetlands, *Domestic wastewater, *Land disposal, *Secondary wastewater treatment, *Biological wastewater treatment, Water pollution control, Artificial wetlands, Swordgrass, Arrowhead, Pennywort, Macrophytes, Comparison studies, Performance evaluation, Biological oxygen demand, Suspended solids, Plant growth.

The rates of removal of BOD5 and suspended solids (SS) from primary effluent using floating and emergent macrophytes cultured in pond and gravel-bed systems were examined. The study was conducted in central Florida, with 3000-L outdoor raceways fed primary domestic effluent at a hydraulic loading of 10 cm/day. Four treatments were established in duplicate tanks: a gravel (1-3 cm river rock)-filled bed with no macrophytes; a gravel bed planted with swordgrass (Scirpus pungens = S. americanus); a gravel bed planted with arrowhead (Sagittaria latifolia); and an open-water system stocked with the floating macrophyte pennywort (Hydrocotyle umbellata). Greatest reductions in wastewater contaminant concentrations were attained in raceways containing pennywort. BOD5 and SS removal rates in pennywort-containing raceways averaged 145 and 41 kg/ha/day, respectively, during the 6-mo study. While mean treatment performance of the gravel-bed system was poorer than that of the pennywort tanks, effluent quality in the raceways containing gravel gradually improved during the study. After 6 mo of operation, effluent wastewater BOD5 and SS concentrations from the arrowhead raceways resembled that of those of the pennywort systems. Although shoot and root standing crop increased contemporaneously with the improvements in the treatment effectiveness of the gravel-bed systems, it is noted that BOD5 and SS concentrations also improved in the unvegetated gravel bed during this period. The time lag observed in the gravel-bed systems may represent the time required for bacterial colonization. Whereas gravel-bed systems, whether vegetated or not, exhibit a gradual improvement in treatment efficiency over the 6-mo study, floating aquatic macrophyte-based systems appeared to operate at peak efficiency immediately following startup. (See also W90-04392) (Rochester-PTT)
W90-04439

AMPLIFICATION OF TOTAL DRY MATTER, NITROGEN AND PHOSPHORUS REMOVAL FROM STANDS OF PHRAGMITES AUSTRALIS BY HARVESTING AND REHARVESTING REGENERATED SHOOTS.
Tohoku Univ., Sendai (Japan). Biological Inst.
T. Suzuki, W. G. A. Nissanka, and Y. Kurihara.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 530-535, 5 fig, 7 ref.

Descriptors: *Land disposal, *Reeds, *Pollutant removal, *Wastewater treatment, *Wetlands, Bio-

logical wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, Nitrogen removal, Phosphorus removal, Seasonal distribution, Biomass, Plant growth, Harvesting.

Studies on natural stands of Phragmites have shown higher concentrations of N and P in younger tissues and decreasing concentrations with maturity. An experiment was designed to establish the best timing for harvest and reharvest of regenerated shoots of Phragmites to amplify removal of total dry matter, N, and P from a Phragmites stand growing under field conditions. Harvesting of a freshwater stand of Phragmites australis was conducted from mid-May 1983 to early November, when the leaves were almost dried and some had fallen. Phragmites shoot biomass increased rapidly early in the growing season, peaked in early August, and then decreased. Harvesting Phragmites shoots twice during the growing season increased the total amount of biomass, N, and P removal from a plot. To amplify removal, the first harvest should occur when maximum nutrient content is reached, with a second harvest when the plant growth ceases in late autumn. Total harvestable biomass with this strategy was 34,000 kg/ha dry wt, 14% higher than the highest amount that could be obtained in a single harvest, and 34% more than a single end-of-growing season harvest. The maximum amount of total N that could be removed from a stand was 365 kg/ha, 22% greater than the highest amount that could be removed by a single harvest, or 90% more than a single end-of-growing season harvest. For P, the maximum total removal was 38.8 kg/ha. This was 10% higher than the highest amount removed by a single harvest and 175% higher than the amount removed by a single end-of-growing season harvest. (See also W90-04392) (Rochester-PTT)
W90-04440

DOMESTIC WASTEWATER TREATMENT USING EMERGENT PLANTS CULTURED IN GRAVEL AND PLASTIC SUBSTRATES.
Florida Univ., Gainesville. Dept. of Soil Science.
P. S. Burgoon, K. R. Reddy, and T. A. DeBusk.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 536-541, 2 fig, 3 tab, 5 ref.

Descriptors: *Wetlands, *Land disposal, *Plant growth, *Florida, *Wastewater treatment, *Wetlands, *Domestic wastes, *Artificial wetlands, *Porosity, *Biological wastewater treatment, Water pollution control, Cattails, Reeds, Arrowhead, Swordgrass, Macrophytes, Comparison studies, Performance evaluation, Biological oxygen demand, Suspended solids, Plant growth, Nitrogen, Phosphorus.

Wetland plant growth and wastewater treatment were compared in two plastic substrates and in 1-cm-diameter gravel. The gravel had a high specific surface area, 48% porosity and the two sizes of plastic media were 2.5 cm and 5.0 cm diameter, medium and low specific surface area, both with high porosity (66-83%). Microcosms (22 L) were filled with substrates and then planted with four emergent plant species: Typha latifolia, Phragmites australis, Scirpus pungens, and Sagittaria latifolia. All plants were grown in gravel but T. latifolia was not grown in either plastic substrate. Sewage was pumped directly from the effluent weir of the primary sedimentation tank at the University of Florida Wastewater Treatment Plant. Effluent was applied at BOD5 and total Kjeldahl N (TKN) mass loading rates of 210 and 45 kg/ha/day. Average influent concentrations of BOD5, TKN, and total P (TP) were 120, 25.4, and 5.1 mg/L. Effluent BOD5 was below 30 mg/L for all treatments. Removal of TKN and TP was highest in the gravel treatments. TP removal averaged 45% for the gravel control, whereas S. latifolia in gravel removed a higher percentage of TP than the other treatments. Effluent concentrations of TKN and TP for S. latifolia and T. latifolia in gravel were both less than 5 mg/L and 3 mg/L, respectively. S. latifolia and S. pungens grew poorly in plastic substrates, whereas P. australis grew well in all three substrates. S. latifolia was very susceptible to a fungus, which was controlled with biweekly applications of the fungicide Benomyl. Biomass production for S. latifolia, P. australis, and S. pungens in gravel averaged 344.2, 223.2, an 10.8 kg/ha/day, respectively. Of the N and P removed from the wastewater, 22% and 18%, respectively, were stored in aboveground biomass of S. latifolia. Wastewater contaminant removal generally was better in the high-specific-surface-area gravel substrate than in the plastic substrates. This was consistent with the three substrate controls, where the gravel effluent had the highest effluent quality. (See also W90-04392) (Rochester-PTT)
W90-04441

AQUATIC PLANT CULTURE FOR WASTE TREATMENT AND RESOURCE RECOVERY.
National Fertilizer Development Center, Muscle Shoals, AL.
J. B. Kingsley, J. J. Maddox, and P. M. Giordano.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 542-549, 2 fig, 4 tab, 12 ref.

Descriptors: *Land disposal, *Alabama, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, *Artificial wetlands, Water pollution control, Macrophytes, Water chestnuts, Cattails, Hay, Reeds, Sludge, Farm wastes, Biological oxygen demand, Suspended solids, Coliforms, Performance evaluation, Fertilizers, Cycling nutrients.

A project was conducted to demonstrate the potential of three aquatic plants to remove pollutants from wastewater and produce useful crops. Demonstrations were conducted in Florence, Alabama, where two types of earthen facilities were built: (1) five units to demonstrate sludge as plant fertilizer in soil flooded with secondary effluent and (2) four units to conduct flow-through demonstrations. Flow-through units were continuously irrigated with secondary effluent. Demonstrations conducted were (1) sludge demonstrations of water chestnut (Eleocharis dulcis) and chestnut hay yields (2 years) and cattail (Typha spp.) (2) flow through demonstrations of water chestnut yields (2 years), cattail and reed (Phragmites australis) yields, and water quality in wetlands (2 years). Artificial wetland water treatment using aquatic plants to absorb nutrients from water can effectively remove pollutants from wastewater and produce an economically valuable crop. Plants recover valuable nutrients lost in conventional wastewater treatment systems, and crops produced can help offset wastewater treatment costs. Optimum flow rate of secondary effluent for waste treatment was 8.1 to 16.2 cm/day, which reduced BOD5 60%, suspended solids 72%, and fecal coliform bacteria >80%. Aquatic plants can recover nutrients from wet sludge (3.5% solids) and sludge is at least as effective as inorganic fertilizer for aquatic plant production. (See also W90-04392) (Rochester-PTT)
W90-04442

BACTERIOLOGICAL TESTS FROM THE CONSTRUCTED WETLAND OF THE BIG FIVE TUNNEL, IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
W. Batal, L. S. Laudon, T. R. Wildeman, and N. Mohdnoordin.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 550-557, 2 fig, 2 tab, 20 ref.

Descriptors: *Land disposal, *Mine wastes, *Colorado, *Wastewater treatment, *Wetlands, *Acid mine drainage, Metal mines, Biological wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, Big Five Tunnel, Bacterial analysis, Bacterial physiology, Pilot plants, Algae, Fungi, Iron, Manganese, Oxidation, Metal removal, Aerobic conditions, Anaerobic conditions.

Wetlands are a potential treatment for small flows of acid mine waters. For metal removal, intrinsic bacterial microflora in a wetland system are important. In the aerobic zone, two groups of heterotrophic metal-utilizing bacteria are present: the Fe and Mn oxidizers and one group of obligate autotrophic iron oxidizers (T ferrooxidans). In the anaerobic zone, sulfate reducers are present. The occurrence, depth, and position of these bacteria in the pilot wastewater treatment wetland at the Big Five Tunnel, Idaho Springs, Colorado, is described. The pilot wetland ecosystem at Big Five Tunnel has three 19-sq m cells, which are 1-m deep. Soils are of three types: mushroom compost (cell A), equal amounts of aged manure, decomposed wood products, and Colorado peat (cell B), and the same soils as in cell B underlain with 10-15 cm of 5-to-8-cm limestone rock (cell C). Sulfate reducing bacteria were found in all cells in relatively high numbers after exposure to 4.4 L/min of mine drainage for 2 mo. Mushroom compost in cell A contained the highest populations of sulfate reducers in the original soil and after 2 mo of flow. Autotrophic iron oxidizers were present initially only in peat, and the population was only 200 bacteria/g. After 2 mo of mine drainage flow, iron-oxidizing autotrophs were present on the surface and at depth in all the substrates. Preliminary results indicate that iron-oxidizing and manganese-oxidizing heterotrophs exist on the surface environment in cells A and C. The algae Ulothrix and Euglena also were present in cell A. On inoculated petri dishes, fungal growth appeared in association with manganese oxidizers. The mycelium was dark and brown crystals were observed under a microscope. In previous studies, the presence of the bacteria observed here was correlated with removal of metals by wetlands; their presence in this constructed wetland suggests that is should be a promising treatment facility. (See also W90-04392) (Rochester-PTT)
W90-04443

USE OF PERIPHYTON FOR NUTRIENT REMOVAL FROM WATERS.
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5G.
W90-04444

DANISH EXPERIENCE WITH SEWAGE TREATMENT IN CONSTRUCTED WETLANDS.
Aarhus Univ. (Denmark). Botanical Inst.
H. Brix, and H.-H. Schierup.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 565-753, 3 fig, 2 tab, 2 ref.

Descriptors: *Land disposal, *Denmark, *Surveys, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, *Reeds, *Artificial wetlands, Water pollution control, Macrophytes, Nitrogen removal, Rhizosphere, Aerobic conditions, Performance evaluation, Oxygen, Permeability, Biological oxygen demand, Nitrogen, Phosphorus, Metals, Coprecipitation, Chemical reactions.

The concept of treating wastewaters with emergent aquatic macrophytes (the root-zone process) was introduced in Denmark in 1983. Basically, this process depends on a horizontal subsurface flow through the rhizosphere of the common reed (Phragmites australis). During passage of wastewater through the rhizosphere, organic matter content of wastewater theoretically should be decomposed by aerobic and anaerobic microorganisms; microbial nitrification and subsequent denitrification should release N to the atmosphere; and P should be removed by chemical coprecipitation with Fe, Al, and Ca compounds in the soil. Reed beds supply oxygen to the aerobic microorganisms in the rhizosphere and increase/stabilize the hydraulic permeability of the soil. Direct assimilation of nutrients by vegetation is considered to be of no significance for the purification ability of the systems because the maximum amount of nutrients that can be removed by harvesting the aboveground biomass is less than 5% of the load on a yearly basis. The root-zone process was introduced as a low-cost, low-technology, decentralized solution capable of producing an effluent quality equivalent to or exceeding conventional tertiary treatment technology. Performance for BOD5, as

well as N and P, was claimed to be better than 90%. The first full-scale treatment facilities were constructed in Denmark during winter 1983-84. The first four years of experience with these constructed reed beds demonstrated the following: (1) performance with respect to BOD5 typically was 70-90%, producing a consistent effluent concentration of less than 20 mg/L after one growing season; (2) typical reduction of total N and total N is 25-50% and 20-40%, respectively; (3) N and P removal depends on hydraulic loading rate and consequent retention time within the reed beds (only facilities with loading rates >2 cm/day show removals of N and P over 50%); and (4) hydraulic permeability of the soil develops slowly, if ever, with overland flow predominating after 4 growing seasons, forming a pattern covering only part of the reed bed area. (See also W90-04392) (Rochester-PTT)
W90-04445

MAN-MADE WETLANDS FOR WASTEWATER TREATMENT: TWO CASE STUDIES.
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.
J. Jackson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 574-580, 2 fig, 2 tab, 3 ref.

Descriptors: *Land disposal, *Wetlands, *Florida, *Wastewater treatment, *Artificial wetlands, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Hardwood swamps, Cattails, Bulrushes, Cypress trees, Maple trees, Nitrogen, Phosphorus, Biological oxygen demand.

Wastewater treatment plant owners and engineers must develop more creative effluent disposal methods using lower-lying or otherwise less desirable lands while adequately protecting surface water resources. Two innovative designs that meet both these needs have been constructed in Lakeland and Orlando, Florida. Prior to its purchase for wastewater treatment, 566 ha of the 650-ha Lakeland site had been used as clay settling ponds for the phosphate mining industry, thus creating an impermeable liner. The constructed wetlands built on this site were designed for a flow of 0.61 cu m/sec, equivalent, to a hydraulic application rate of 1 cm/day. Design criteria included reducing influent concentrations of 20 mg/L BOD5), 20 mg/L total suspended solids (TSS), and 8 mg/L total ammonia as nitrogen (NH3-N) to 5 mg/L BOD5, 10 mg/L TSS, and 1.0 mg/L NH3-N. Total P removals of 50% also were expected. The chosen disposal option was creation of a 494-ha man-made wetlands on an improved pasture to further treat water prior to discharge to the St. Johns River. The pasture was segmented by berms into small cells, with weir structures to control flow distribution, depth, and detention time. A wet prairie (170 ha) was planted primarily with cattail (Typha latifolia) and bulrush (Scirpus californicus). From the wet prairie, water flows into a 154-ha mixed marsh, which was started with 10 spp. but now has about 60 spp. The final community is a 162-ha hardwood swamp that includes a 49-ha lake. The swamp was planted with seedlings of bald cypress, red maple, loblolly bay (Gordonia lasianthus), water oak, dahoon holly (Ilex cassine), and other tree species. The constructed wetlands site was designed to receive 0.88 cu m/sec of water with 6 mg/L total N and 0.75 mg/L total P. For the 494-ha site, this is equivalent to nutrient loadings of 0.92 kg/ha/day and 0.11 kg/ha/day for total N and total P. Both the Lakeland and Orlando wetland systems have achieved permitted effluent requirements, although loaded at less than design conditions. Based on the present treatment occurring in the first cells, as flows are increased, more of the system will be used for treatment, but continued compliance with permitted effluent limits is expected. (See also W90-04392) (Rochester-PTT)
W90-04446

RESEARCH TO DEVELOP ENGINEERING GUIDELINES FOR IMPLEMENTATION OF CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT IN SOUTHERN AFRICA.
Steffen, Robertson and Kirsten, Inc., Johannesburg (South Africa).
A. Wood, and L. C. Hensman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 581-589, 4 tab, 7 ref.

Descriptors: *Land disposal, *South Africa, *Design criteria, *Wastewater treatment, *Artificial wetlands, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Rural areas, Developing countries, Arundo, Reeds, Cattails, Municipal wastewater, Industrial wastewater, Performance evaluation.

Natural wetlands form an important barrier against nonpoint source discharges of most heavily industrialized areas of South Africa. Research is now underway at a number of locations to evaluate the potential for constructed wetlands in wastewater treatment as a simple, low-cost, low-technology approach to the problem. Studies investigating the controlling factors responsible for efficient operation and design of wetland systems include (1) the substrata responsible for most nutrient removal and hydraulic capacity of the system; (2) macrophyte species responsible for aeration and enhancing permeability; and (3) effluent characteristics, loading rates, and retention times in the operational regime. A former fish dam, 5 m x 5 m x 1 m, was lined with hyperplastic membrane (Carbofol 500 micrometer) protected by a 50-mm sand layer prior to filling with coarse gravel (19 mm) and planted with local Arundo donax receiving septic sewage at 10 cm/sq m/day. Arundo fully occupied the be within 4 mo. Two other lined dams were converted to wetlands in upgrading studies of 12 small-scale units. One system with power-station waste ash is planted with Phragmites and loaded with raw sewage. Effluent flows into a Phragmites bed with a local soil covered in a layer of coarse ash. In another study, a combined artificial wetland and high-rate algal pond was constructed that consisted of two units, each 22 m x 11 m x 40 cm. Septic sewage is loaded to the wetland at a rate of 135 L/sq m/day. Effluent from the bed is pumped from the sump into the algal pond. The gravel bed is planted with Typha (for denitrification) and A. donax. Over 1 yr, effluent COD levels were reduced 59%, NH4-N 34%, PO4-P 31%, and suspended solids 77%. Other projects of various designs have been constructed at Mpophomeni, Grootvlei Power Station, Olifansvlei Sewage Works, Johannesburg, and in two rural areas of Gazankulu. Constructed wetlands have considerable potential in southern Africa for treatment of raw wastewaters emanating from rural communities, for upgrading oxidation pond and secondary effluents to general and special discharge standards, and for treatment of industrial effluents. (See also W90-04392) (Rochester-PTT)
W90-04447

CONSTRUCTED WETLANDS: DESIGN, CONSTRUCTION AND COSTS.
Dames and Moore, Boston, MA.
K. J. Whalen, P. S. Lombardo, D. B. Wile, and T. H. Neel.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 590-596, 1 fig, 5 ref.

Descriptors: *Land disposal, *Maryland, *Wastewater treatment, *Design criteria, *Wetlands, *Artificial wetlands, Bulrushes, Biological wastewater treatment, Water pollution control, Macrophytes, Construction methods, Cost analysis, Wastewater engineering, Carbon, Nitrogen.

Constructed wetlands have successfully treated settled domestic wastewater, but most wetlands have been pilot projects or small-scale treatment works. Design and construction issues are discussed here based on the example of a constructed bulrush (Scirpus olneyi) wetland that is the principal component of the 1770 cu m/day Mayo Water Reclamation Subdistrict Large Communal Water Reclamation Facility. Septic tank effluent collected from 2000 homes is treated before discharge into the Chesapeake Bay. Engineering issues discussed include: design parameters (process/conceptual design, basin design (liner, baffles, media, vegetation, and storm impact); process control; construction; and costs. It is recommended that the development of community-scale wetland treatment facilities for N removal include consideration of the following issues: (1) process-conceptual aspects, including target removal, carbon source, and C/N ratio; (2) basin characteristics, including liner, baffles, length/width ratio, media, vegetation, and storm impact; and (3) process control aspects, including adjustment of C/N ratios, variable loadings, adjustable hydraulic loadings, and odor control. Construction of wetlands is very similar to construction of lined ponds. Construction of wetlands should be modular to match treatment capacity to flow and to facilitate recovery of capital cost of expanding the treatment facilities to serve future users. Wetlands startup should consider hydraulic balance to ensure that a critical water level is maintained in the wetland to maintain vegetation. Construction cost was equivalent to $530/cu m/day of treated wastewater capacity due to uncompetitive contractor environment and the use of crushed rock media rather than natural gravel. (See also W90-04392) (Rochester-PTT)
W90-04448

WASTEWATER TREATMENT/DISPOSAL IN A COMBINED MARSH AND FOREST SYSTEM PROVIDES FOR WILDLIFE HABITAT AND RECREATIONAL USE.
James Engineering, Inc., El Cerrito, CA.
B. B. James, and R. Bogaert.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 597-605, 4 fig, 1 tab, 3 ref.

Descriptors: *Land disposal, *California, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, Forests, Marshes, Recreation, Wildlife habitats, Pilot plants, Invertebrates, Mammals, Amphibians, Reptiles, Biological oxygen demand, Suspended solids, Nitrogen removal.

The Mt. View Sanitary District in Martinez, California, established 3.6 ha of freshwater wetlands in 1973 to process secondary effluent. It was expanded to 8.5 ha in 1977. In 1979, a pilot project combining a forest area and marsh was added. In 1984 and 1987, respectively, 9 ha and 16 ha of seasonal wetlands were added, bringing the total size to approximately 37 ha. Operating experience on two wetlands constructed in the 1970s and the marsh/forest pilot project, which receives secondary effluent from the district's wastewater treatment plant as the sole water source. The system reduces BOD5, suspended solids, and ammonia N, although the wetland tends to have higher suspended solids level than the influent water in summer due to algal growth. The algae are removed in the marsh/forest. A measure of the success of the wetland project is its ability to sustain a diverse community of plants and animals. Over 70 spp. of plants and 123 spp. of water fowl have been identified on the site. The area also supports a diverse community of invertebrates, fish, amphibians, reptiles, and small mammals, including river otters (Lutra canadensis). Fifteen years of operating wetlands and marsh/forest reclamation systems has demonstrated that it is possible to provide a richly varied aquatic habitat through careful management of reclaimed wastewater. The area now provides a valued wildlife habitat that is a popular recreation spot. Nine years experience with a prototype marsh/forest evapotranspiration system has shown that a marsh system can be designed and managed to provide a high quality water as well as wildlife habitat. It also demonstrates that it is possible to take advantage of the high water demand of selected trees to reduce or eliminate reclaimed water discharge to sensitive receiving waters. (See also W90-04392) (Rochester-PTT)
W90-04449

ROOT-ZONE SYSTEM: MANNERSDORF. NEW RESULTS.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
R. Haberl, and R. Perfler.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 606-621, 11 fig, 6 tab, 17 ref.

Descriptors: *Land treatment, *Austria, *Wastewater treatment, *Artificial wetlands, *Reeds, *Wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Performance evaluation, Research facilities, Coliforms, Salmonella, Retention time, Evapotranspiration, Tracer studies, Isotopic tracers, Mannersdorf.

The Mannersdorf (Austria) experimental sewage treatment system is one of the first research-oriented wetland plants. Four experimental plots of equal size (10 x 15 m) were laid out and sealed with vertical membrane barriers. Individual plots were supplied from a receptacle with a measuring weir having aboveground distribution of PVC pipeline with branching manifolds. Humus deposits interlaced with reed (Phragmites australis) rhizome shoots from the bankside area of the neighboring receiving stream were applied to a depth of 0.3 m. Since June 1984, plot 1 has been fed raw sewage, plot 2 with settled sewage, and plots 3 and 4 with biologically treated sewage effluent. Feed rate per plot was initially 20-30 mm/day. The feed rate has been increased in line with treatment performance of the system to 50-60 mm/day. Inlet concentrations of communal sewage to the plots varied widely, but daily variation causes no immediate influence on effluent quality. Varying feed rates (20-60 mm/day) hardly affected the plant removal efficiency. Increased influent caused enhanced superficial runoff and required a longer travel distance for a given reduction in contamination. Retention time, determined from tracer experiments with uranine and NaCl, showed no consistent pattern. Maximal values may be severely affected by water losses from evapotranspiration. Tracer experiment results in plots 1 and 2 indicated that most of the flow (60-80%, depending on the rate of feed) occurs in the near-surface region or in the litter layer. Only plot 3 has predominantly deeper flow layers (80%). Rates of elimination of saprophytes and coliforms were (1) raw sewage plot, 96-98% and 92-96%, (2) settled sewage plot, 95-99% and 98%, and (3) biologically treated sewage plot, 89-95% and 93-97%. Of a total of 72 samples, 24 were contaminated with Salmonella. Results of the research plant in Mannersdorf of Lower Austria demonstrate that root-zone systems may contribute to the solution of wastewater treatment in areas with 100-500 person-equivalents (PE). It seems necessary to have a mechanical pretreatment before the wetland plant. The treatment area for 1 PE should be 5-10 sq m. (See also W90-04392) (Rochester-PTT)
W90-04450

CONSTRUCTED WETLANDS FOR SECONDARY TREATMENT.
Nolte (George S.) and Associates, Sacramento, CA.
T. J. Mingee, and R. W. Crites.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 622-627, 1 fig, 2 tab.

Descriptors: *Land disposal, *California, *Secondary wastewater treatment, *Wetlands, *Biological wastewater treatment, *Artificial wetlands, Water pollution control, Macrophytes, Cost analysis, Pilot plants, Comparison studies, Cattails, Bulrushes, Biological oxygen demand, Suspended solids.

Gustine, CA, is a small agricultural town on the west side of the San Joaquin Valley, with a population of about 4000. Climate in the area is characterized by hot, dry summers and cool winters. Average annual rainfall is about 0.29 m, mainly from November through March. The city treats approximately 4542 cu m/day of wastewater, of which one-third originates from domestic and commercial sources and the remainder comes from three dairy products industries. Analysis of alternatives to upgrade the wastewater plant showed that an oxidation pond/constructed wetland system was most cost-effective. Advantages included availability of suitable land, compatibility of the treatment method with the surrounding area lowest life-cycle cost, consumption of very little energy. A pilot study was conducted from December 1982 to October 1983 to verify the efficacy of constructed wetland to develop design criteria. An existing stand of cattail near the treatment was modified by constructing enclosure berms, piping, and pumps to simulate a portion of the constructed wetlands envisioned for the full-scale project. The wetlands systems consists of 14 cells operated in parallel, each measuring 11.6 m by 337 m (0.4 ha). Depth is adjustable at cell outlet weirs over a range of 0.1 to 0.45 m. Levees, 3 m wide and 0.6 m high, separate the cells. The wetlands system and other treatment plant improvements were constructed in 1986 and 1987. Project specifications required 18 cells to be planted with cattail (Typha) on 0.9-m centers and 6 cells with bulrush (Scirpus fluviatilis) on 0.5-m centers. Without full plant coverage, the wetland portion of the treatment plant is still in the startup phase of operation. Performance of the system as a whole has not reached design expectations, partly because flow and BOD5 entering the treatment plant are significantly higher than design values. However, reduction of BOD5 (66%) and suspended solids (54%) are significant. Exclusive of land (9.7 ha), which was city-owned, project costs were $882,000 to treat a design loading 3785 cu m/day amount to $233/cu m/day. (See also W90-04392) (Rochester-PTT)
W90-04451

HYDRAULIC CONSIDERATIONS AND THE DESIGN OF REED BED TREATMENT SYSTEMS.
Water Research Centre, Stevenage (England).
J. A. Hobson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 628-635, 7 fig.

Descriptors: *Land disposal, *Reeds, *United Kingdom, *Wastewater treatment, *Wetlands, *Design criteria, *Hydraulic engineering, Biological wastewater treatment, Water pollution control, Macrophytes, Reed bed treatment systems, Darcys law, Hydraulic gradient, Biological oxygen demand, Suspended solids, Performance evaluation.

The United Kingdom program on reed bed treatment systems (RBTS) is concentration almost exclusively on beds planted with Phragmites australis, the common reed. Information on work conducted so far on such systems is discussed, including mechanisms of treatment in RBTS and application of Darcy's law to flow design in RBTS. A proper solution to Darcy's law for a reed bed is not straightforward due to the way variations in the saturated cross-sectional area perpendicular to the flow affects the hydraulic gradient. However, it usually is possible to estimate a satisfactory solution. Due to an oversimplified application of Darcy's law, many early reed beds in the United Kingdom were built with a slope. Future beds probably will have level surfaces or very gently sloping bases for the following reasons: (1) because of the very large range of possible hydraulic conductivities in a reed bed, it should be possible to operate a level bed with a hydraulic gradient of 1% (5% for short beds); (2) to avoid erosion of a downward sloping surface, beds designed with the expectation of treatment in the F-horizon should be flat or have a very slightly upward-sloping surface; and (3) water level is easier to control on a flat bed than a downward-sloping one. Gravel beds seem to be favored over soil beds and are much easier to design. However, in side-by-side comparisons of soil and gravel beds, soil beds give superior treatment if surface flow is avoided. This was demonstrated by early results at 6-m-long beds at Audlem, and similar differences have been noted in 1-m-long beds at Stevenage. The soil beds tend to produce low BOD5 values, but high figures for suspended solids. This may imply a washout of soil particles for considerable periods after a soil bed is commissioned. In coarse-medium beds, the position is reversed. Effluents are often clear, with low suspended solids, but with comparatively high BOD5 values, suggesting that in the early days of a gravel bed, treatment is largely by physical filtration. (See also W90-04392) (Rochester-PTT)
W90-04452

USE OF ARTIFICIAL CATTAIL MARSHES TO TREAT SEWAGE IN NORTHERN ONTARIO, CANADA.
Hanna (J.E.) Associates, Inc., Pickering (Ontario).
G. Miller.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 636-642, 2 fig, 2 tab, 2 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Ontario, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Cattails, Rural areas, Performance evaluation, Bulrushes, Muskrats, Biological oxygen demand, Suspended solids, Bacterial analysis, Coliforms, Phosphorus.

In July 1980, the Listowel Marsh wastewater treatment project was begun in southwestern Ontario. The project showed that a properly configured cattail (Typha) marsh could significantly improve the quality of sewage wastewaters. The present report concerns an attempt made in 1981 to transfer the Listowel approach to the community of Cobalt, more than 300 miles farther north. Marsh design was based on information from the Listowel facility. A cell of in situ materials lined with offsite clay was constructed 310 m by 3 m (0.1 ha) with a serpentine configuration. Plot loading approximated 0.2 L/sec (170 cu m/ha/day, 19.00 mm/day) fo raw sewage. Depth was maintained at 15 cm to keep retention time near the seven-day period used at Listowel; this was increased in winter to maintain 15 cm of water under an ice layer. One year after planting, cattail covered most of the marsh area, and bulrush (Scirpus) and smartweed (Polygonum) had invaded. Muskrat tunneled through the berms during the winter, causing the channel to dry and the cattails to die. They were replanted after repairs were made, but this was unnecessary because seedlings recolonized the area. The BOD5 in raw sewage averaged 21.7 mg/L. Passage through the marsh reduced BOD5 by 80%, producing an average effluent of 4.1 mg/L with maximum levels below 15 mg/L. Suspended solids in raw sewage averaged 31.9 mg/L. Excluding three anomalies, effluent suspended solids averaged 10.9 mg/L, well below the secondary effluent objective of 15 mg/L. Total P in treated sewage averaged 1.53 mg/L; in marsh outflow it was 0.66 mg/L, 57% less and within the design objective of 1 mg/L. Bacterial counts were consistently high going into the plots, but output counts varied. Out of 33 paired input/output samples for fecal streptococci, 29 showed lower bacterial populations in the outflow. Similarly, fecal coliforms were lower in 32/33 paired comparisons. Under the best of conditions, the marsh is capable of discharging an effluent that meets swimming and bathing water quality objectives. (See also W90-04392) (Rochester-PTT)
W90-04453

SOME ANCILLARY BENEFITS OF A NATURAL LAND TREATMENT SYSTEM.
Grand Strand Water and Sewer Authority, Conway, SC.
A. L. Schwartz, and R. L. Knight.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 643-645.

Descriptors: *Land disposal, *South Carolina, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Swamps, Carolina Bays, Recreation, Performance evaluation, Management planning, Species diversity.

The Grand Strand Water and Sewer Authority (GSW+SA) is a countywide water and sewer utility in South Carolina's most rapidly growing county, Horry County. Suitable land application sites within the county are scarce; a consultant suggested using naturally occurring riverine wetlands and locally unique wooded swamps known as 'Carolina Bays' as land application sites. Carolina Bays are poorly-drained, elliptical basins confined within a raised sand rim, making them appear ideal for wastewater treatment. Over 336 ha of Carolina Bay areas are contained within a cluster of four Carolina Bays selected for one treatment plant service area. A riverine swamp of 142 ha is contained within another service area. One bay and the riverine slough have been permitted as pilot projects for receiving secondary effluent. They have performed as expected after 15 mo of discharge. The only measurable vegetative changes were slightly increased tree growth rates. For the future use of Carolina Bays, the criterion for protection of these wetlands during wastewater treatment is to allow greater or lesser change for each bay depending on its history of prior human alteration. The most altered bays will be permitted for higher wastewater loading rates than the less affected bays. Specific criteria selected for each bay are measurable and are linked to plant density, dominance, and diversity, and to bird diversity. In addition to providing pilot-scale results, this project has encouraged interested state and federal agencies to develop agreed-upon criteria for protection of specific wetland areas throughout the state. Part of the project is to include walkways into the bays, which are normally difficult to access because of dense vegetation, thus providing recreational and educational benefits in addition to wastewater treatment. (See also W90-04392) (Rochester-PTT)
W90-04454

PERFORMANCE OF SOLID-MATRIX WETLAND SYSTEMS, VIEWED AS FIXED-FILM BIOREACTORS.
Hawkesbury Agricultural Coll., Richmond (Australia). Faculty of Food and Environmental Sciences.
H. J. Bavor, D. J. Roser, P. J. Fisher, and I. C. Smalls.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 646-656, 3 fig, 4 tab, 3 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Australia, *Wastewater treatment, *Wetlands, *Biological wastewater treatment, Water pollution control, Macrophytes, Cattails, Bulrushes, Myriophyllum, Biological oxygen demand, Suspended solids, Nitrogen removal, Performance evaluation, Phosphorus removal, Coliforms, Mathematical models, Temperature, Detention time, Pollution load, Kinetics.

Wastewater treatment performance of solid-matrix, constructed wetland systems was investigated during the design, operation, and maintenance of seven large-scale units at Richmond, Australia, over a 3.5-yr period. The design and construction of these constructed wetlands, the effect of loading rate on pollutant removal, the effect of seasonality on pollutant removal, nitrification potential of the macrophyte system microbial populations, denitrification, and hydraulic behavior are described. The systems consisted of lined trenches planted with Typha orientalis or Scirpus validus in gravel and a floating macrophyte, Myriophyllum aquaticum, growing in open water with no solid matrix. Domestic sewage and primary (settled) and secondary effluent from a trickling filter/maturation pond were used at hydraulic loadings from 0.2 to 1.4 mL/ha/day. Effective removal of BOD5 (annual mean 95%), suspended solids (94%), and total nitrogen (67%) was achieved by the systems when operating at hydraulic detention times of 2-10 days. Indicator bacteria were reduced by up to 5 orders of magnitude. Phosphorus removal, however, was low (15%). The Myriophyllum system was the least effective of the design formats tested. Removal of suspended solids, BOD5, N, P, and fecal coliforms was investigated in relation to loading, detention time, and temperature to allow predictive modeling of system performance, assuming first-order removal kinetics and treating the units as fixed-film bioreactors. For a number of effluent constituents, first-order removal kinetics may not describe adequately the removal performance. Improved models are being developed. (See also W90-04392) (Rochester-PTT)
W90-04455

FATE OF MICROBIAL INDICATORS AND VIRUSES IN A FORESTED WETLAND.
East Tennessee State Univ., Johnson City. Dept. of Environmental Health.
P. R. Scheuerman, G. Bitton, and S. R. Farrah.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 657-663, 1 fig, 4 tab, 15 ref. EPA Grant R809402.

Descriptors: *Florida, *Land disposal, *Bioindicators, *Fate of pollutants, *Bacteria, *Viruses, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Swamps, Cypress trees, Septic wastewater, Performance evaluation, Streptococcus, Bacteriophage.

Waldo, Florida, has been using overflow from a concrete septic tank into a 2.6-ha cypress wetland since 1934 as a method of wastewater treatment. The behavior of bacterial and viral indicators after discharge was monitored by setting up two parallel corridors in unimpacted cypress wetlands and conducting sampling under various operational conditions. Septic tank effluent was applied continuously at 49 L/min from May 1 to November 18, 1983. The present results, like those obtained by others, suggest that initial rapid removal of microorganisms is followed by a slower decline and that part of the microbial population is able to undergo long-term survival. Previous results indicating that fecal streptococci accumulated in sediments of the experimental corridors were confirmed. Decay rates showed that fecal streptococci (indigenous bacteria) and Streptococcus faecalis (laboratory bacteria in test chambers) are removed at the slowest rate. This confirms an earlier conclusion that fecal streptococci may be a more conservative indicator for fecal pollution. Bacteriophage were removed at a slower rate than bacterial indicators or enteroviruses. Enteroviruses appeared to decline at the greatest rate and did not accumulate in the sediments. With sufficient time and distance, microbial quality of sewage effluents is improved after discharge into wetlands. Since at least part of the microbial population can undergo long-term survival, the use of a more conservative indicator may be prudent. (See also W90-04392) (Rochester-PTT)
W90-04456

WASTEWATER WETLANDS: USER FRIENDLY MOSQUITO HABITATS.
Marin Sonoma Mosquito Abatement District, Petaluma, CA.
C. H. Dill.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 664-667, 2 fig, 2 tab, 1 ref.

Descriptors: *California, *Mosquitoes, *Insect control, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Macrophytes, San Francisco Bay, Wastewater irrigation, Encephalitis, Public health, Mosquito fish.

In California, in and around San Francisco Bay, irrigated wastewater treatment wetlands represent a possible breeding ground for mosquitoes. Of particular concern is the encephalitis mosquito (Culex tarsalis), which can transmit western equine encephalomyelitis and St. Louis encephalomyelitis. To manage mosquito populations, appropriate design and water management are required, as well as vegetation selection. U.S. Public Health Service recommendations for malaria control are valid in this context. With the ability to raise, lower, and even eliminate the water if necessary, vegetation is less critical. Most types of emergent vegetation are tolerable if water levels can be drawn down below the vegetation and a good population of mosquito fish is present. A wastewater project at Las Gallinas was designed with mosquito control input and has had only a local pest problem from mosquitoes. In contrast, a wastewater project at Santa Rosa developed up to 500-600 female Culex tarsalis per night. Source reduction and planning reduced this number to 50/night. Since 10,700 m of drainage ditches was constructed to remove runoff water to a return pond, where it can be used again for irrigation. Return ponds are stocked with mosquito fish and have not created problems as long as the fish survive and the vegetation is managed. Good preventive design coupled with water management vegetation control normally will be enough to minimize mosquito problems. Continued surveillance is necessary, though, because problems at treatment plants or unusually hot weather can easily kill of resident mosquito fish populations, resulting in emergence of very large numbers of mosquitoes in a short period of time. Mosquito control must be a basic element of the preproject planning as well as in operation and management documents for all treated-effluent systems. (See also W90-04392) (Rochester-PTT)
W90-04457

DEVELOPMENT OF AN URBAN RUNOFF TREATMENT WETLANDS IN FREMONT, CALIFORNIA.
Bowling Green State Univ., OH. Environmental Health Program.
G. S. Silverman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 669-676, 2 tab, 5 ref.

Descriptors: *California, *Urban runoff, *Storm water, *Wastewater treatment, *Land disposal, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Crandall Creek, Cattails, Design criteria, Financing, Institutions, Organizations.

A 20-ha fallow agricultural field in Fremont (Alameda County), California, was converted into a seasonal freshwater wetlands for managing urban stormwater runoff traveling in Crandall Creek. Institutional considerations, treatment mechanisms, design, and potential for stormwater wetlands are discussed. Three distinct systems were incorporated into the wetlands: (A) a long, narrow pond containing a long island, and with vegetation (mainly Typha latifolia) encouraged along the pond margins; (B) a spreading pond draining into an overland flow system (inundated only during storms), followed by a pond with berms supporting aquatic vegetation; and (C) a common third system into which the others drain, which provides meandering channels to maximize contact with various types of wetlands, and drains into another section of the Coyote Hills Regional Park, ultimately returning to Crandall Creek. Hydraulic considerations included sizing the diversion structure and channels to accommodate the 10-yr, 6-hr storm, with greater flows causing diversion structure failure, with most of the flow remaining in Crandall Creek. Development of this wetlands provided a number of benefits. An attractive wetlands has been created in an urbanized region badly needing additional 'natural' areas and a facility to study potential and future designs for urban runoff treatment systems has been provided. Another important benefit is the practical demonstration for implementation of other wetlands development projects. Development of the Fremont wetlands required active efforts from the regional council of governments and park district, financial support from the state and federal governments, and the cooperation of a host of local agencies and special districts. It demonstrated the need and potential for obtaining diverse support for wetlands projects. (See also W90-04392) (Rochester-PTT)
W90-04458

URBAN RUNOFF TREATMENT IN A FRESH/BRACKISH WATER MARSH IN FREMONT, CALIFORNIA.
Association of Bay Area Governments, Oakland,

CA.
E. C. Meiorin.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 677-685, 3 fig, 2 tab, 8 ref.

Descriptors: *California, *Urban runoff, *Storm water, *Wastewater treatment, *Land disposal, *Artificial wetlands, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Crandall Creek, Demonstration wetlands, Heavy metals, Cattails, Bulrushes, Bioaccumulation, Tissue analysis, Carp, Gambusia, Chromium, Nickel, Copper, Zinc, Lead, Monitoring, Biological oxygen demand, Suspended solids, Manganese.

A temporary stormwater detention system for improvement of water quality was constructed in Fremont, California, in 1983. The wetland system and its control structures receive water from approximately 1200 ha: 66% low-density residential, 28% agricultural open space, 5% high-density residential, and 1% commercial and urban road. The marsh was monitored during the wet seasons of 1984-85 and 1985-86 to document marsh development and treatment effectiveness. The wetland system covers approximately 22 ha and consists of three separate subsystems: (A) a lagoon flow-through system with 1:4 slope on lagoon margins and depth ranging from 1.8 to 2.4 m; (B) an overflow area (0.5% slope, dry between storms), which leads to a pond with underwater sills vegetated with cattails and (C) a system of braided channels into which the other systems drain (4.7 ha open water, 4.2 ha vegetated with bulrushes and cattails). Measured stormwater runoff volumes from 11 storms entering the marsh ranged from 13,400 to 69,200 cu m, with calculated peak flows of 0.22 to 1.2 cu m/sec. Static capacity of the DUST (Demonstration of Urban Stormwater Treatment) marsh is 71,700 cu m. Trap efficiency for suspended constituents was 42-45% for solids, 30-83% for Pb, 40-53% for Cr, 12-34% for Ni, 6-51% for Zn, and 5-32% for Cu. For total dissolved solids, BOD5, and manganese, trap efficiencies were negative. Bioaccumulation of heavy metals was apparent in both plants and fish. Heavy metal concentrations in fish (carp, Gambusia) tissues generally were below the ambient soil and sediment concentrations for Cr, Pb, Mn, and Ni. The source of the metal contamination appears to be the sediments, but other factors than stormwater input may be involved. Overall, the DUST marsh was effective in reducing total suspended solids and inorganic N, P, and Pb, regardless of the system. Because the degree and significance of bioaccumulation of pollutants in the food chain is as yet unclear, use of wetlands to treat urban stormwater runoff should be limited to constructed wetlands. (See also W90-04392) (Rochester-PTT)
W90-04459

DESIGN OF WET DETENTION BASINS AND CONSTRUCTED WETLANDS FOR TREATMENT OF STORMWATER RUNOFF FROM A REGIONAL SHOPPING MALL IN MASSACHUSETTS.
IEP, Inc., Northborough, MA.
P. Daukas, D. Lowry, and W. W. Walker.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 686-694, 3 fig, 1 tab, 2 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Massachusetts, *Urban areas, *Urban runoff, *Hydrologic engineering, *Storm water, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Cattails, Arrowhead, Sweet flag, Bulrushes, Millet, Reed canary grass, Roads, Parking lots, Detention reservoirs, Biological oxygen demand, Dissolved solids, Oil pollution, Heavy metals, Deicers.

Runoff from parking lots and roadways contains high concentrations of suspended solids, nutrients, trace metals, oil and grease, and deicing salts. A case study is presented of water quality mitigation measures for the 83,600-cu m Emerald Square Mall, North Attleborough, Massachusetts. The project site encompasses 23 ha and is located within the watershed of the Sevenmile River, which contributes to the drinking water supply of the City of Attleboro. For controlling stormwater runoff quality, the design and operation of the Emerald Square Mall include the following measures: wet detention ponds, constructed wetland basins, catch basins equipped with oil and grease traps, parking lot sweeping, sodium-free deicing salts, and restricted use of herbicides, pesticides, and fertilizers. Wetland basins were established during the first construction phase to provide at least one full growing season prior to receiving parking lot runoff. The basins are designed as shallow marsh communities on organic soil. Approximately 35,000 tubers of indigenous marsh emergents were planted at the following percentages: 30% cattail (Typha latifolia), 25% arrowhead (Sagittaria latifolia), 25% bulrush (Scirpus validus), and 20% sweet flag (Acorus calumus). Side slopes were seeded with millet (Echinochloa sp.) and reed canary grass (Phalaris arundinacea). Wetland shrubs also were planted to enhance the 'edge' effect around the wetlands. A range of pollutant removal efficiencies was estimated as follows: suspended solids, 80-95%; total P, 60-85%; total N, 40-70%; BOD5, 50-80%; sodium, 0; cadmium, 50-50%; chromium, 50-90%; copper, 50-90%; lead, 80-95%; mercury, 50-90%; and zinc, 50-90%. Mass balance calculations suggested that development of Emerald Square Mall with the described runoff measures should not affect adversely the use of Sevenmile River for water supply. Long-term monitoring of treated runoff will be used to detect water problems that may develop during mall operation. (See also W90-04392) (Rochester-PTT)
W90-04460

CREATION OF WETLANDS FOR THE IMPROVEMENT OF WATER QUALITY: A PROPOSAL FOR THE JOINT USE OF HIGHWAY RIGHT-OF-WAY.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Liaison Office.
For primary bibliographic entry see Field 5G.
W90-04461

WETLANDS TREATMENT OF DAIRY ANIMAL WASTES IN IRISH DRUMLIN LANDSCAPE.
Lough Gara Farms Ltd., Boyle (Ireland).
C. J. Costello.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 702-709, 3 fig, 1 tab, 5 ref.

Descriptors: *Land disposal, *Ireland, *Farm wastes, *Dairy industry, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Ammonia, Biological oxygen demand, Performance evaluation, Filtration, Lough Gara.

Lough Gara Farms Limited produces approximately 450,000/yr of milk on a site that drains into Lough Gara, a 1700-ha, shallow, bog-fringed lake of 13 m maximum depth in Ireland. Problems with pollution from the site were approached by a three-part program: (1) an independent environmental study of the lake's physical, chemical, microbiological, and ecological characteristics to determine the impact, if any, of the existing wastewater treatment system on the lake; (2) a design study aimed at improving the design, functioning, and operation the existing system; (3) prepare, with costing, plans to carry out works requested by the Sligo County Council (SCC); and (4) reinvestigate the suitability of land for the spreading of slurry as requested by SCC. The waste treatment system begins with delivery of slurry to interlinked 2-m-deep by 2.5-m-wide trenches on impervious soil with a capacity of 800 cu m. The daily volume of material fed into this system consists of feces and urine, 7500; milking parlor washings 7500 L; rain washings in unroofed yard areas, 5000 L; and rainfall in the slurry collection channels, 4000 L, a total of 24,000 L/day. A gate controls flow so that the liquid fraction can undergo a second anaerobic fermentation in a chamber of 200 cu m with limestone filter at the outlet. Filtered liquid (3600 cu m/yr) is fed into the wetlands treatment area. The wetlands treatment area is divided into two zones: a former lake bed of 6.4 ha, with peat and vegetation, and a zone of 5.5 ha that falls 1 m to the Lough Gara level. Effluent treatment produced a 99.1-99.95% reduction in BOD5 concentrations, although on some occasions levels exceeded 200 mg/L. Ammonia concentrations were reduced by up to 94.5%; nitrate concentrations were reduced up to 95.4%; and orthophosphate concentrations were reduced up to 91.3%. (See also W90-04392) (Rochester-PTT)
W90-04462

POTENTIAL ROLE OF MARSH CREATION IN RESTORATION OF HYPERTROPHIC LAKES.
Saint Johns River Water Management District, Palatka, FL.
For primary bibliographic entry see Field 5G.
W90-04463

UTILIZATION AND TREATMENT OF THERMAL DISCHARGE BY THE ESTABLISHMENT OF A WETLANDS PLANT NURSERY.
Anne Arundel Community Coll., Arnold, MD.
For primary bibliographic entry see Field 3C.
W90-04464

EXPERIMENTS IN WASTEWATER POLISHING IN CONSTRUCTED TIDAL MARSHES: DOES IT WORK. ARE THE RESULTS PREDICTABLE.
Lehigh Univ., Bethlehem, PA. Center for Marine and Environmental Studies.
V. G. Guida, and I. J. Kugelman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 727-734, 4 tab, 15 ref.

Descriptors: *Land disposal, *New Jersey, *Tidal marshes, *Food-processing wastes, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Activated sludge, Biological oxygen demand, Suspended solids, Nitrogen removal, Phosphorus removal, Performance evaluation.

Three environmental factors relevant to the potential success of constructed tidal marshes are discussed based on experimental results: (1) whether tidal flooding frequency, which shortens wastewater residence to a few hours, can prevent effective treatment; (2) whether the behavior of pristine tidal marshes is a good indicator of their ability to polish wastewater; and (3) whether the outcome of polishing is readily predictable in a variable natural marsh. Experiments were performed at the Wetlands Institute near Stone Harbor, New Jersey. Clam processing wastewater was treated by extended aeration activated sludge in two 440-L fill-and-draw units. Polishing experiments were performed on outdoor marsh microcosms. Tidal flooding was simulated to follow the schedule of natural flooding using water pumped from a tidal creek. Water quality measurements were made on three occasions and mass balance analyses were conducted. The predictability of removal results was estimated using linear regression analysis. With appropriate corrections, BOD5 removal from effluents in January, May, and August experiments ranged from 29% to 100%; total suspended solids, 58-108%; total N, 69-98%; and total P, 30-73%. These results are comparable to those obtained with other marsh polishing systems and improve activated sludge effluents enough to meet direct discharge standards. (See also W90-04392) (Rochester-PTT)
W90-04465

POTENTIAL USE OF CONSTRUCTED WETLANDS TO TREAT LANDFILL LEACHATE.
Geological Survey, Tacoma, WA.
W. W. Staubitz, J. M. Surface, T. S. Steenhuis, J. H. Peverly, and M. J. Lavine.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural.

Lewis Publishers, Chelsea, Michigan. 1989. p 735-742, 1 fig, 2 tab, 22ref.

Descriptors: *Land disposal, *Artificial wetlands, *New York, *Landfills, *Leachates, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Reeds, Cattails, Bulrushes, Feasibility studies, Performance evaluation, Plant growth, Seasonal variation, Design criteria, Hydraulic engineering.

Infiltration of precipitation and migration of water through municipal solid waste landfills produce leachate that contains undesirable or toxic organic and inorganic chemicals. The feasibility of constructed wetlands for landfill-leachate treatment is under investigation in New York State by several agencies. The study is designed to investigate the fate and transport of landfill leachate in a constructed wetland and provide engineering design data for construction and operation of full-size leachate treatment systems. Specific objectives are to examine: (1) the efficiency of leachate treatment as a function of substrate material, plant growth, leachate quality, and seasonal change in climate; (2) the effects of leachate application and plant growth on the hydraulic characteristics of the beds; (3) the effect of leachate on plant viability; and (4) the physical and chemical processes by which metals are fixed and transformed. The wetlands are modified versions of root-zone or rock-reed filter systems. They have gently sloping beds lined with an impermeable barrier and planted with emergent hydrophytes such as reeds (Phragmites), bulrush (Scirpus), or cattails (Typha). The wetlands generally have an inlet zone of crushed stone to distribute wastewater evenly over the bed width and an outlet zone of crushed stone to collect and discharge effluent. Construction of eight wetland plots (30 m long x 3 m wide x 0.6 m deep and planted with Phragmites australis) began in the spring of 1988. Plans are underway for monitoring these constructed wetlands so that water and chemical mass loadings and treatment efficiency of each plot can be calculated. Hydraulic conductivity experiments on bed materials and greenhouse studies of plant tolerance for transplantation, plant nutrient requirements, and effects of rhizome growth on hydraulic conductivity. Growth in loamy sand was excellent, but complete inorganic fertilizer was needed to prevent chlorosis. Root or rhizome growth for 3 mo had little or no effect on hydraulic conductivities. (See also W90-04392) (Rochester-PTT)
W90-04466

NATURAL RENOVATION OF LEACHATE-DEGRADED GROUNDWATER IN EXCAVATED PONDS AT A REFUSE LANDFILL.
South Dakota State Univ., Brookings.
For primary bibliographic entry see Field 5G.
W90-04467

BIOLOGY AND CHEMISTRY OF GENERATION, PREVENTION AND ABATEMENT OF ACID MINE DRAINAGE.
Silver (Marvin) Scientific Ltd., Bedford (Nova Scotia).
For primary bibliographic entry see Field 5B.
W90-04468

DESIGN AND CONSTRUCTION OF A RESEARCH SITE FOR PASSIVE MINE DRAINAGE TREATMENT IN IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
E. A. Howard, J. C. Emerick, and T. R. Wildeman.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 761-764, 1 fig, 1 tab, 8 ref.

Descriptors: *Land disposal, *Research facilities, *Colorado, *Acid mine drainage, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Cattails, Sedges, Big Five Tunnel, Monitoring, Hydrogen ion concentration, Temperature, Oxidation-reduction potential, Metals.

The Idaho Springs-Central City mining district in the foothills of the Colorado Front Range has massive waste rock dumps, mill tailings piles, and abandoned mine shafts and tunnels form precious metal ore production. Tunnel drainage typically has low pH and high metal concentrations that adversely affect regional water resources. At Big Five Tunnel, a Superfund listed site within this district, a demonstration treatment system was built to determine the fate of metals within a wetlands system, to observe vegetation survival upon metals exposure in a mountain climate, to study function and distribution of bacteria in the system, and to identify appropriate organic substrates and plant species. A reinforced concrete structure 3.05 by 18.3 m was divided initially into three 6.1-m sections, with provisions for future subdivision to six compartments. Cattails (Typha latifolia) and sedges (Carex utriculata, C. aquatilis) were transplanted from a lake at similar elevation into 25-30% of each treatment bed. Later, sedges (C. aquatilis) and rushes (Juncus arcticus) were transplanted from a fen and covered 25% of the treatment beds. Additional cattails and sedges from a foothills wetland made up the remaining area in the treatment beds. Water sampling of mine drainage, outputs from the three cells, and waters from six access wells in each compartment have been initiated. Temperature, pH, Eh, conductivity, and dissolved oxygen contents of the waters are measured in the field. Over 20 constituents are being monitored routinely in waters, substrates, and plants (live leaves, dead leaves, flowers, and roots). (See also W90-04392) (Rochester-PTT)
W90-04469

MANGANESE AND IRON ENCRUSTATION ON GREEN ALGAE LIVING IN ACID MINE DRAINAGE.
Memphis State Univ., TN. Dept. of Biology.
S. E. Stevens, K. Dionis, and L. R. Stark.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 765-773, 3 fig, 14 ref. DOI, Bureau of Mines Contract PO373662.

Descriptors: *Land disposal, *Wetlands, *Acid mine drainage, *Fate of pollutants, *Precipitation, *Chlorophyta, Bioaccumulation, Manganese, Iron, Electron microscopy, Wetlands, Sedimentation ponds, Pennsylvania, Ohio, Energy dispersive spectroscopy, Metal removal.

Many species of algae are known to tolerate acid mine drainage (AMD) resulting from coal mining. Algae were collected from wetlands and sediment ponds receiving coal mine drainage. Samples used in the present study were collected as grab samples from various locations in Pennsylvania and Ohio. Filaments of algae were prepared one of two ways, depending on whether they were to be analyzed for metal content by energy dispersive spectroscopy (EDS) or analyzed and photographed with the scanning electron microscope (SEM). Oedogonium, Mougeotia, and Microspora were the genera most commonly found growing encrusted in AMD. The algal encrustations varied in color from rust red to blackish brown and in shape from rough, irregular globules to smooth cylinders. In general, encrustations contain mostly Fe if the Fe concentration in the water is moderate to high regardless of the Mn concentration. If the Fe concentration is low, encrustations contain Mn. The mechanism by which metals are deposited on cell wall material is unknown. In Fe-rich waters, Fe salts will coat submerged surfaces. However, this passive coating does not appear to play a dominant role in the formation of encrustations in the algae studied here. Within established filaments, encrustations appear to be restricted to single cells or groups of cells, with clear areas in between. Two possibilities are suggested: deposition could result from a structural or physiological property of the alga, or deposition could result from the activities of epiphytic microorganisms. The role of metal-encrusting algae in metal removal from AMD is not clear. Ultimately, the significance of these algae in the treatment of AMD will depend on metal removal efficiencies, the relative dissolution of the precipitated metals when algal filaments die, and the density of algae within the treatment system. (See also W90-04392) (Rochester-PTT)
W90-04470

DETERMINING FEASIBILITY OF USING FOREST PRODUCTS OR ON-SITE MATERIALS IN THE TREATMENT OF ACID MINE DRAINAGE IN COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
E. A. Howard, M. C. Hestmark, and T. D. Margulies.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 774-779, 1 fig, 11 ref.

Descriptors: *Colorado, *Acid mine drainage, *Wastewater treatment, *Water pollution treatment, *Heavy metals, *Wetlands, *Metal removal, Water pollution control, Litter, Forests, Chemical analysis, Feasibility studies, Manganese, Zinc, Cadmium, Chelating agents.

Abandoned or inactive metal mines release effluents with low pH and high dissolved metal concentrations. In high-altitude sites in Colorado, climatic conditions can preclude construction and maintenance of conventional treatment systems. Forest litter materials were analyzed to see if they possessed appropriate characteristics for use as media in treating acid mind drainage. Litter and humus layers beneath spruce-fir (Picea engelmannii, Abies bifolia), lodgepole pine (Pinus contorta), ponderosa, and aspen (Populus tremuloides) were obtained from locations near Idaho Springs, Colorado, and common charcoal briquettes were purchased. Tests performed included cation exchange capacity (CEC) and metal ion removal efficiency for Mn, Zn, and Cd. Experiments were conducted in 3-cm-diameter glass columns with stopcocks for controlling the flow. A stock solution was prepared with 750 mg/L Mn, 1000 mg/L Zn, and 200 mg/L Cd. Because decrease in the efficiency of metal ion uptake was the objective, each column was washed 5 times with stock solution equivalent to 30, 60, 90, 120, and 170% of the total CEC. Removal efficiencies were the difference between initial concentrations and concentrations after passage through the column. Ponderosa and aspen had better ion exchange than lodgepole and spruce-fir litter and humus. However, the CEC (from sodium saturation) did not adequately estimate the cumulative percent removal capacities of litter and humus samples. For example, the ponderosa litter and humus had the highest CEC, but ponderosa had the lowest cumulative percent metal removal of the forest types, and at 90% of total CEC, ponderosa was not much better than charcoal. The spruce-fir sample had the lowest CEC of the forest types, but its cumulative percent removal was similar to aspen at 90% of total CEC. Overall trends in the efficiency of removal are consistent and decrease markedly as 60-90% of CEC is reached. All four forest materials tested removed metal ions, but spruce-fir and aspen decomposition materials had higher cumulative removal efficiencies and should be tested in pilot-scale field situations. (See also W90-04392) (Rochester-PTT)
W90-04471

USE OF WETLANDS TO REMOVE NICKEL AND COPPER FROM MINE DRAINAGE.
Minnesota Dept. of Natural Resources, St. Paul. Minerals Div.
P. Eger, and K. Lapakko.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 780-787, 3 fig, 3 tab, 7 ref.

Descriptors: *Land disposal, *Minnesota, *Acid mine drainage, *Wastewater treatment, *Wetlands, *Metal removal, Water pollution control, Litter, Feasibility studies, Nickel, Copper, Cobalt, Zinc, Peat, Sedges, Cattails.

Drainage form mineralized Duluth Complex stockpiles located at the Dunka Mine in northeastern Minnesota contains elevated concentrations of Ni, Cu, Co, and Zn and has increased metal concentrations in nearby receiving waters up to 400 times

the natural background concentrations. A passive treatment approach involving wetlands appears to be capable of treating all the drainage 600 ML/yr at less than half the capital cost and less than a twentieth the annual maintenance cost of a conventional treatment plant. To determine the capability of wetlands to treat stockpile drainage, a survey of local peat wetlands and their peats was conducted. The wetlands ranged in size from 1-20 ha, with average depths of 0.2-1.2 m. Peat was generally well decomposed, with decomposition increasing with depth. It was primarily a sedge peat with wood fragments. Metal concentrations varied depending on the sites' proximity to the existing stockpile drainage. Cu ranged from 40-724 mg/kg, Ni from 19-740 mg/kg, and pH from 5.25-7.45. Ash content was 10-60%, with the highest ash content in the areas with the shallowest peat. Metal retention capacities and total removal capabilities for the peat wetlands were estimated. Dividing the total removal capacity by the annual Ni loading resulted in estimated treatment system lifetimes of 20 to several hundred years. Further detailed research was conducted on a individual wetland area with the objectives of (1) optimizing treatment efficiency with different flow distribution methods and vegetation types, (2) measuring system life, and (3) developing data for application to full-scale treatment systems. Four treatment cells (6 m by 30.5 m) have been constructed and will be used to evaluate four treatments: two low-water (5 cm) treatments with natural vegetation (Carex sp. and grasses) and two high-water (15 cm) treatments with cattails (Typha sp.). Flow paths will be different in the different cells. Based on laboratory experiments, residence times in all cells will be 48 hr. Surface water and groundwater will be monitored monthly in each of the four plots. (See also W90-04392) (Rochester-PTT)
W90-04472

WINDSOR COAL COMPANY WETLAND: AN OVERVIEW.
American Electric Power Corp., Lancaster, OH.
R. L. Kolbash, and R. L. Romanoski.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 788-792, 4 fig.

Descriptors: *Land disposal, *Artificial wetlands, *West Virginia, *Acid mine drainage, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Seepage, Cattails, Compost, Iron, Manganese, Hydrogen ion concentration, Algae, Plant growth, Performance evaluation.

A wetland has been constructed at Windsor Coal Company's Beech Bottom Mine (West Virginia) with the goal of minimizing refuse pile seepage at the Schoolhouse Hollow Refuse Area. Contaminated seepage is collected and channeled into a small pond at the toe of the refuse pile. Collected seepage is treated with caustic soda, which results in fluctuating pH levels with occasional elevations of iron. The wetland consists of 0.5-cm limestone, 46 cm of sterile mushroom compost, and cattail (Typha) plants, all resting on a Hypalon liner. The wetland rests in an excavated area of 3.4 m by 26 m, with a total surface area of 117 sq m. A rock/pipe drain was installed to carry water from a 4 L/min seep. Cattails were installed on 46-cm centers and seep water was directed into the wetland. Even with less than one growing season, the Windsor wetland has removed 50% of the incoming iron. Inlet and outlet total Mn and pH are generally similar, although on three occasions outlet pH was substantially elevated above inlet pH. The Hypalon liner seems to be enhancing algae growth. Continuing monitoring will measure sulfate and inlet flow and will evaluate the long-term effects of the Hypalon liner on the wetland. (See also W90-04392) (Rochester-PTT)
W90-04473

WETLAND TREATMENT OF COAL MINE DRAINAGE: CONTROLLED STUDIES OF IRON RETENTION IN MODEL WETLAND SYSTEMS.
Villanova Univ., PA. Dept. of Biology.
J. Henrot, R. K. Wieder, K. P. Heston, and M. P. Nardi.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 793-800, 3 fig, 1 tab, 15ref.

Descriptors: *Land disposal, *Artificial wetlands, *Acid mine drainage, *Iron removal, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Peat, Pilot plants, Oxidation, Performance evaluation, Mosses, Hydrogen ion concentration, Temperature, Organic matter.

A pilot study was initiated to evaluate Fe retention in wetlands under controlled conditions. Six model wetlands (2.40 x 0.15 m) filled with Sphagnum substrate were subjected to influent water at a pH of 4.0 and Fe concentrations of either 0, 50, or 100 mg/L. At the end of the 8-day treatment period, effluent Fe concentrations were approximately equal to influent Fe concentrations. Peat chemical analysis indicated that (1) Fe retention was more pronounced at the inflow end and (2) accumulated Fe was mainly present as organically bound Fe (63.8% of total Fe) and Fe oxides (29.1%), with little accumulation as exchangeable Fe. This study and field studies suggest that a key process involved in Fe retention in wetland systems is Fe oxide formation. Microbially-mediated Fe oxidation, which probably was inhibited in this pilot study by high greenhouse temperatures, may play an important role in Fe retention and increase the 'effective' life of wetlands created for the treatment of acid mine drainage. (See also W90-04392) (Rochester-PTT)
W90-04474

TOLERANCE OF THREE WETLAND PLANT SPECIES TO ACID MINE DRAINAGE: A GREENHOUSE STUDY.
Pennsylvania State Univ., University Park. Dept. of Biology.
W. R. Wenerick, S. E. Stevens, H. J. Webster, L. R. Stark, and E. DeVeau.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 801-807, 2 fig, 2 tab, 11 ref. Bureau of Mines Contract PO373662.

Descriptors: *Land disposal, *Pennsylvania, *Acid mine drainage, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Peat, Pilot plants, Oxidation, Performance evaluation, Cattails, Mosses, Chlorophyll a, Plant physiology, Stress, Iron, Manganese, Hydrogen ion concentration, Plant pathology, Aquatic plants, Tolerance.

A greenhouse study was conducted to assess the feasibility of using wetland plants for treating acid mine drainage (AMD) at two central Pennsylvania sites. At one of the sites conditions approached the limits of toleration of wetland plants in the field (411 mg/L dissolved Fe, 71 mg/L dissolved Mn, and pH 3.4-3.5). The greenhouse study attempted to assess the tolerance of Typha latifolia (cattail), Sphagnum recurvum (peat moss), and Pohlia nutans (a subaquatic turf-forming moss) to AMD. Seep water was collected at the mine site and used in the preparation of water treatments. Four water treatments were used: tap water control, mine water diluted 1:4 (1 vol mine water and 3 vol tap water), mine water diluted 1:2, and undiluted mine water. Dilution with tap water increased pH and reduced dissolved metal concentrations. On the basis of total chlorophyll content, Typha was the most resistant to AMD, followed by Pohlia and then by Sphagnum. Chlorophyll a/b ratios declined in Typha in response to AMD stress, whereas in both Sphagnum and Pohlia the chlorophyll a/b ratio increased. This effect may have been due to interference with Mn uptake caused by the high total and dissolved Fe in the AMD samples. Undiluted mine water had a significant negative effect on leaf growth in Typha, whereas mine water diluted 1:2 was associated with growth about the same as the control and mine water diluted 1:4 was associated with better growth than the control. Taken as a whole, the results suggest that Typha was the most generally tolerant of the plant species tested, but if the meaning of the changes in chlorophyll a/b ratios in Sphagnum and Pohlia were understood, a different conclusion might be necessary. (See also W90-04392) (Rochester-PTT)
W90-04475

CONTROL OF ARMYWORM, SIMYRA HENRICI (LEPIDOPTERA: NOCTUIDAE), ON CATTAIL PLANTINGS IN ACID DRAINAGE TREATMENT WETLANDS AT WIDOWS CREEK STEAM-ELECTRIC PLANT.
Tennessee Valley Authority, Muscle Shoals, AL. Vector and Plant Management Program.
E. L. Snoddy, G. A. Brodie, D. A. Hammer, and D. A. Tomljanovich.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 808-811, 1 fig, 11 ref.

Descriptors: *Land disposal, *Alabama, *Wastewater treatment, *Wetlands, *Insect control, Biological wastewater treatment, Water pollution control, Cattails, Armyworms, Rushes, Insecticides, Management planning.

Due to the monocultural nature of the macrophytes used in constructed wetlands, some plants, particularly Typha latifolia (cattail) are subject to damage by lepidopterous insects, mainly of the armyworm complex. A constructed wetlands was established in May 1986 to aid in the control of acid mine drainage from an abandoned ash pond. Cattails were planted in three cells, with cattail and rush (Juncus effusus) in the third cell. By August 1986, an infestation of the cattail armyworm, Simyra henrici (Grt.) was observed. Vegetation destruction was heavy. The insecticide Lorsban was applied by aerial spraying at a rate of 1.15 kg/ha (Beecomist spray heads). This procedure resulted in >95% control. It is unclear why the population density of caterpillars was much higher at Widows Creek compared to nearby natural wetlands. A routine inspection of plantings for insect pests should be conducted beginning early in the season. General plans should be made for control action if an outbreak of armyworms occurs. (See also W90-04392) (Rochester-PTT)
W90-04476

OIL WATER SEPARATORS. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855431. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 108 p. Supersedes PB88-858089.

Descriptors: *Bibliographies, *Cleanup operations, *Oil spills, *Water pollution treatment, *Wastewater treatment, Separation techniques, Coalescence, Filters, Flotation, Literature review.

This bibliography contains 243 citations concerning the utilization of oil-water separators in the marine, manufacturing, and petrochemical industries. Gravity separators, coalescers, filters, and flotation units are among the equipment types considered. Design considerations, and system descriptions and evaluations are presented. Utilization of a variety of devices in oil spill clean up operations is discussed. Thirty- two of the citations are new entries to the previous edition. (Author's abstract)
W90-04477

EFFLUENT TREATMENT IN THE TEXTILE INDUSTRY: EXCLUDING DYES. JANUARY 1983-JANUARY 1989 (CITATIONS FROM THE WORLD TEXTILE ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855266. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 110 p. Supersedes PB87-

864252.

Descriptors: *Bibliographies, *Wastewater treatment, *Textile mill wastes, *Industrial wastewater, *Wastewater renovation, *Water reuse, Air pollution control, Water pollution control, Zinc, Literature review.

This bibliography contains 300 citations concerning the treatment and reuse of textile industry effluents. Effluents that contain dyes are discussed in a separate bibliography. Recovery of lubricants, lye, sizing agents, polyvinyl alcohol, zinc, dirt, and heat from textile effluents is discussed. Air and water pollution control technology that is effective in treating textile effluents is included. Effluents from synthetic fiber manufacture and wool scouring processes are emphasized. Eighty-four citations are new entries to the previous edition. (Author's abstract)
W90-04481

ACTIVATED CARBON: UTILIZATION IN SEWAGE AND INDUSTRIAL WASTE TREATMENT. JANUARY 1987-DECEMBER 1988 (CITATIONS FROM THE NTIS BIBLIOGRAPHIC DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-853063. Price codes: NO1 in paper copy, NO1 in microfiche. January 1989. 84 p. Supersedes PB88-855549.

Descriptors: *Bibliographies, *Wastewater treatment, *Activated carbon, Industrial wastes, Literature review, Performance evaluation, Regeneration.

This bibliography contains 93 citations concerning the use of activated carbon for the treatment of sewage and industrial wastes. Topics include performance evaluations at specific sites, engineering studies, and regeneration techniques. Applications in sewage treatment, coal conversion, petrochemical, and various other industries are presented. Citations pertaining to air pollution control are excluded. Nineteen citations are new entries to the previous edition. (Author's abstract)
W90-04483

ION EXCHANGE RESINS. JANUARY 1988-DECEMBER 1988 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3A.
W90-04486

ION EXCHANGE RESINS. OCTOBER 1983-DECEMBER 1987 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3A.
W90-04487

WASTEWATER TREATMENT BY SAND FILTRATION. JANUARY 1977-FEBRUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161. Supersedes PB86-860053. Prepared in cooperation with Office of Water Research and Technology, Washington, DC. Price codes: N01 in paper copy; N01 microfilm. Mar 89. 105p.

Descriptors: *Bibliographies, *Wastewater treatment, *Filtration, *Sand filters, Literature review, Domestic wastes, Industrial wastewater, Sanitary engineering.

This bibliography contains 164 citations concerning the use of sand filtration in the treatment of wastewater. Treatment systems for both domestic and industrial effluents are discussed. Designs, processes, applications and performance evaluations of sand filters, columns and mounds as primary filtering mechanisms are included. Thirty-three citations are new entries to the previous edition. (Author's abstract)
W90-04499

5E. Ultimate Disposal Of Wastes

BIOTECHNOLOGY FOR DEGRADATION OF TOXIC CHEMICALS IN HAZARDOUS WASTES.
For primary bibliographic entry see Field 5D.
W90-03562

PHYSICAL-CHEMICAL AND ANAEROBIC FIXED FILM TREATMENT OF LANDFILL LEACHATE.
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03571

TREATMENT OF LEACHATE FROM A HAZARDOUS WASTE LANDFILL SITE USING A TWO-STAGE ANAEROBIC FILTER.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
Y. C. Wu, O. J. Hao, and K. C. Ou.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 196-220, 6 fig, 6 tab, 41 ref. Army Construction Engineering Research Laboratory Grant DACA 888 EC 0013.

Descriptors: *Waste disposal, *Water pollution prevention, *Biofiltration, *Landfills, *Leachates, *Wastewater treatment, *Hazardous wastes, *Biological treatment, *Anaerobic digestion, Biological wastewater treatment, Organic matter, Chemical oxygen demand, Biochemical oxygen demand, Volatile acids, Ammonia, Metals, Nitrogen compounds, Nitrification, Alkalinity, Gas.

Leachate from a hazardous waste landfill site contained a high concentration of organic matter and low metal concentrations. Chemical oxygen demand (COD), biochemical oxygen demand (BOD) and volatile acid (VA) were approximately 21, 14, and 1.9 gm/L, respectively. Both the strength and chemical composition of raw leachate varied with sampling time. The high ratio of BOD to COD of raw leachate is amenable to biological treatment. With an organic loading up to 4 g COD/day/sq m, COD/BOD removal was satisfactory, even though the leachate contained several toxic pollutants. BOD as low as 130 mg/L or a 98% reduction could be achieved. Thus, the anaerobic filters can be used to treat concentrated leachate without the effluent recycle and without any pretreatment. The biofilters were very effective for metal removal. However, the anaerobic process did not remove ammonia and the effluent NH3-N concentration often increased due to degradation of nitrogenous organic matter. Either chemical process or biological nitrification may be employed to remove residual BOD and ammonia to an acceptable level. Due to the large volume of the first reactor, almost all of the organic matter reduction and gas production occurred in the first stage reactor. Once the first stage was upset, the second reactor was unable to degrade VA present in the first stage effluent. The overloading was characterized by the accumulation of large quantities of VA, a low ratio of VA/alkalinity, and reduction of gas. (See also W90-03562) (Lantz-PTT)
W90-03572

EFFECTS OF EXTENDED IDLE PERIODS ON HAZARDOUS WASTE BIOTREATMENT.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
A. S. Weber, M. R. Matsumoto, J. G. Goeddertz, and A. J. Rabideau.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 221-243, 8 fig, 4 tab, 6 ref.

Descriptors: *Idle time, *Waste disposal, *Water pollution prevention, *Wastewater treatment, *Biological wastewater treatment, *Hazardous wastes, *Performance evaluation, Chemical oxygen demand, Temperature, Biodegradation, Activated carbon, Biological treatment, Feasibility studies, Operating policies, Aeration, Groundwater pollution, Landfills.

An experimental study was conducted to assess the technical feasibility of biological processes treating hazardous waste when extended periods of inoperation are imposed on operation protocol. The impetus for this study was to develop a process that could provide cost effective treatment of leachate and contaminated groundwater from a former hazardous waste handling facility in Upstate New York. Waste collection rates at the site are expected to be low and as such, intermittent process operation will be desirable or necessary. Based on the reported findings of the experimental study, intermittent biological treatment can achieve significant removal of waste pollutants. In this study the rate of chemical oxygen demand (COD) removal was adversely affected by decreases in operation frequency and decreased operating temperatures. However, if reaction periods are extended, all biodegradable COD removal can be removed in bioreactors using long lag periods. Addition of powdered activated carbon was tested under one operating scenario and hypothesized to be advantageous in reducing aeration times for conditions of low temperature and extended lag periods. While the feasibility of intermittent biological treatment was studied using a groundwater contaminated with hazardous waste substances, other potential applications exist. They include: (1) leachate treatment of municipal and hazardous waste landfills; (2) industrial waste flows released on an intermittent basis; and (3) other waste sites requiring remediation. (See also W90-03562) (Lantz-PTT)
W90-03573

BIOLOGICAL DEGRADATION OF POLYCHLORINATED BIPHENYLS.
General Electric Corporate Research and Development, Schenectady, NY. Biological Sciences Branch.
R. Unterman, M. J. Brennan, R. E. Brooks, and C. Johnson.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 376-386, 3 fig, 5 ref.

Descriptors: *Soil contamination, *Cleanup, *Decontamination, *Waste disposal, *Polychlorinated biphenyls, *Biodegradation, Corynebacterium, Alcaligenes, Pseudomonas, Microbial degradation.

The release and accumulation of polychlorinated biphenyls (PCBs) in the environment, and possible effects on human health have sparked an intense interest in devising technologies for their destruction or safe disposal. Biodegradation of various soil-bound PCBs under a variety of conditions, using both pure and mixed cultures of Corynobacterium sp., Alcaligenes eutrophus, and Pseudomonas putida, is demonstrated in this study. The authors conclude that it should be possible to biologically degrade PCBs on contaminated soil in the environment with appropriate cell concentrations and moisture conditions. Continuing studies are now focusing on experimental conditions that most closely model an actual site decontamination process. (See also W90-03562) (Lantz-PTT)
W90-03581

COMBINED FIXED BIOLOGICAL FILM MEDIA AND EVAPORATIVE COOLING MEDIA TO SOLIDIFY HAZARDOUS WASTES FOR ENCAPSULATION AND EFFICIENT DISPOSAL.
S. F. Roe.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 489-503, 4 fig, 10 ref.

Descriptors: *Waste disposal, *Waste solidification, *Waste encapsulation, *Wastewater treatment, *Biological wastewater treatment, *Biofilms, *Fixed film processes, *Hazardous wastes, *Cooling, *Evaporation, Solidification, Cooling towers, Volatile organic compounds, Anaerobic digestion, Biotechnology, Aerobic treatment, Evaporation ponds, Evaporators, Incineration, Scaling, Fouling, Farm wastes, Industrial wastes.

Evaporation process common in evaporative cooling for agricultural and industrial uses can be used in wastewater treatment in combination with biotechnology, volatile stripping, and other conventional unit operations to promote scaling or fouling the evaporative cooling media, encapsulating it, and disposing of it as a solid waste. A second possibility is to incinerate the evaporative cooling media containing the hazardous waste. Existing technology is discussed in terms of conventional evaporation, utility cooling tower evaporation, evaporative cooling, VOC stripping, and fixed film biotechnology. Possible evaporation techniques include ambient-temperature evaporation, as well as evaporation/biotechnology combinations such as evaporation followed by anaerobic digestion, anaerobic digestion followed by aerobic treatment (a trickling-filter, activated-sludge, or 'super bug' process) followed by evaporation, and evaporation followed by aerobic treatment. The evaporative cooling process is perhaps intermediate between evaporative ponds and multistage evaporators. This process shares the low energy and capital costs of evaporative ponds without the disadvantage of rain-water dilution suffered by evaporative ponds. Yet this process shares the chemical-plant heritage of multistage evaporators in that it is a predictable, reliable crossflow tower without the fouling problems of multistage evaporators. The evaporative process for hazardous waste concentration and disposal is certainly not a universal solution to all hazardous waste problems, but must be tailored to the properties of the waste. Then it must be evaluated on a pilot or full scale basis. (See also W89-03562) (Lantz-PTT)
W90-03589

PROCESSES OF BALLAST WATER DISPERSAL.
ENTRIX, Inc., Anchorage, AK.
J. M. Colonell, H. J. Niebauer, and D. L. Nebert.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 39-67, 8 fig, 3 tab, 51 ref.

Descriptors: *Arctic zone, *Wastewater disposal, *Ballast water, *Valdez, *Fate of pollutants, *Alaska, Tides, Diffusion, Advection, Model studies, Flushing.

The various time and space scales involved with dispersion of treated ballast water in Port Valdez, Alaska, are discussed. Near-field dilution, with time scales of < 1 hr and space scales of 0.5 km or less is controlled by turbulent dissipation of buoyancy and momentum. In Port Valdez the near-field diffusion is generated and controlled by an outfall diffuser system that discharges the treated ballast water into the fjord. Far-field diffusion, defined by time scales of hours-days and space scales of < 5 km, is controlled by eddy diffusion and advective transport. Far-field diffusion occurs after the outfall jet has lost its initial momentum and buoyancy. Model studies for Port Valdez suggest that far-field diffusion processes can produce dilutions of 1:2.5-5 and 1:5-10 at distances of 500 m and 1 km, respectively, from the diffuser. The ultimate fate of the ballast water has time and space scales of weeks to years and 10's of km (the dimensions of Port Valdez) and is controlled by the advective transport and flushing mechanisms of the port. Tidal flushing appears to result in a flushing time of water in the fjord of about 4 weeks. The slow intrusion of dense water from outside the fjord into the basin appears to renew the deepest waters at least annually. Surges of water in and out of Port Valdez, apparently associated with passage of weather systems through the area, appear to flush the fjord in a range of several days to a few weeks. Therefore, work to this point suggests that a composite residence time for Port Valdez would not exceed several weeks. (See also W90-03610) (Lantz-PTT)
W90-03613

INFLUENCE OF RIVER REGIME ON THE FLOOD MANAGEMENT OF SUKKUR BARRAGE, PAKISTAN.
I. G. G. Hogg, K. Guaganesharajah, P. D. S. Gunn, and P. Ackers.
IN: International Conference on River Regime. Hydraulics Research Limited, Wallingford, Oxon, UK. 1988. 331-354, 12 fig, 5 ref.

Descriptors: *Pakistan, *Flood control, *Channel morphology, *Regime streams, *Sediment transport, Channel roughness, Channel resistance, Scour, Model studies, White-Paris-Bettes equation, Plane bed function.

Varying combinations of discharge, sediment transport, channel roughness and downstream hydraulic control, make flood water levels on the Indus river difficult to predict with any precision. Because the agricultural lands severed by the Indus barrages are crucial to the economy of Pakistan, it is important to ensure that adequate flood management procedures are in place. On the basis of observed flood behavior, there is no single valued relationship between either sediment concentration, or channel roughness, and discharge. In general, flow appears to be in upper regime on a rising flood hydrograph. Under these conditions, channel resistance is relatively low and water velocities are correspondingly high. At about the time of peak flow, the regime becomes transitional; channel resistance increases on the falling hydrograph and lower regime conditions are re-established. Significant changes in sediment inflow may modify this pattern, as happened in 1976; a sudden fall in sediment concentration led to abrupt scour and rapid transition to lower regime flow. Design procedures must take into account the possibility of regime changes, particularly around peak discharge. The modeling of design floods should be carried out with a combination of representative sediment concentrations and channel roughnesses. Channel roughness may be expressed in terms of channel resistance; the White-Paris-Bettes equation may be used in lower regime flow and a plane bed function in upper regime. (See also W90-03626) (Author's abstract)
W90-03652

TECHNICAL SUPPORT DOCUMENT: LANDFILLING OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136584. Price codes: A14 in paper copy, A01 in microfiche. 1988. 324p, 5 fig, 20 tab, 3 append.

Descriptors: *Sludge disposal, *Landfills, *Waste disposal, *Waste management, Management planning, Regulations, Wastewater disposal.

The report describes good landfill management practices, but does not refer to specific regulatory requirements. Landfilling is a sludge disposal method in which sludge is deposited in a dedicated area, alone or with solid waste, and buried beneath a soil cover. Landfilling is primarily a disposal method, with no attempt to recover nutrients and only occasional attempts to recover energy from the sludge. About 41% of the municipal wastewater sludge generated in the United States is landfilled. When siting a monofill, special consideration must be given to evaluating sites near airports, 100-yr floodplains, wetlands, fault areas, seismic impact zones, and unstable areas. Requirements for siting monofills in each of these types of locations have been established by the proposed sewage sludge regulations to prevent adverse impacts to human health and the environment. Six areas of management practice requirements are specified by the proposed sewage sludge regulations. One of these six, pathogen reduction, is covered under separate title. The remaining five--landfill cover requirements, disease vector controls, explosive gases controls, access controls, and run-on/runoff controls are discussed. These management practices are required under Subtitle D or C of the Resource Conservation and Recovery Act and have been incorporated to some extent into the proposed sewage sludge regulation. (Lantz-PTT)
W90-03744

TECHNICAL SUPPORT DOCUMENT: SURFACE DISPOSAL OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136600. Price codes: A06 in paper copy, A01 in microfiche. 136p, 5 fig, 20 tab, 86 ref.

Descriptors: *Sludge disposal, *Land disposal, *Waste management, *Waste disposal, Regulations, Groundwater quality, Model studies, Path of pollutants, SLUDGEMAN, Standards, Landfills, Management planning.

A number of different methods have been developed to reuse or dispose of sludge by application to land. Monofilling and land application (including agricultural and nonagricultural applications and distribution and marketing) have been considered in the regulation of sewage sludge under Part 503 of the Clean Water Act. A surface application practice termed surface impoundment is used as a treatment method or for interim storage. Another current practice is to dispose of sewage sludge by placing it in 'piles' on land surface. The EPA is proposing to call the use of surface impoundments and waste piles sewage sludge surface disposal. In developing the risk assessment methodology for each sludge disposal option, the EPA used mathematical models that would predict the average long-term human health and environmental effects of continually disposing of sludge in the soil and/or water. The SLUDGEMAN model was developed to predict the maximum allowable pollutant concentrations in sewage sludge at a landfill that would not detrimentally affect the most exposed individual (MEI). This model (or a modification) will probably be used for the surface disposal option because the movement of pollutants in the soil and into the groundwater is similar for both practices. Proposed 405(d) sewage sludge regulations are based on maximum pollutant limits that have been calculated for each sludge pollutant evaluated for this regulation. For SLUDGEMAN, the EPA selected reasonable worst-case values for monofill site characteristics to calculate these maximum allowable sludge concentrations (pollutant limits). The sludge pollutant concentrations are limited to the less stringent of the following: 98th% concentrations reported in the EPA 40-cities study; and pollutant concentrations derived from the monofilling risk assessment. Six areas of management practice requirements are specified by the proposed sewage sludge regulations. One of these six, pathogen reduction, is covered under separate title. Of the remaining five, landfill cover requirements are not relevant to surface disposal. Disease vector controls, explosive gases controls, and access controls are discussed. The growing of food and feed crops on surface disposal units as well as animal grazing will be prohibited. These management practices are required under Subtitle D or C of the Resources Conservation and Recovery Act (RCRA) and have been incorporated to some extent into the proposed sewage sludge regulation. (Lantz-PTT)
W90-03745

REGULATORY IMPACT ANALYSIS OF THE PROPOSED REGULATIONS FOR SEWAGE SLUDGE USE AND DISPOSAL.
Environmental Protection Agency, Washington, DC. Economic Analysis Div.
For primary bibliographic entry see Field 6E.
W90-03761

GM SYSTEM USERS MANUAL GEOSYNTHETIC MODELING SYSTEM; CSC VERSION 1.00.
Computer Sciences Corp., Cincinnati, OH.
C. L. Patterson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-151195.

Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/2-88/029, January 1988. 23p, append. EPA Contract 68-01-7176.

Descriptors: *Waste disposal, *Handbooks, *Computer models, *Waste dumps, *Landfills, Reservoirs, Wastewater disposal, Computer programs, Performance evaluation, Containment, Design criteria.

The development of guidance design procedures for the evaluation of geosynthetic materials used in containment systems for landfills, surface impoundments and waste piles has been computerized to increase the speed of calculation of results and to reduce the frequency of human error resulting from manual calculations. Potential failure modes for each geosynthetic component are established. A design procedure is developed for evaluating each of the potential failure modes. Each design procedure is based on calculation of service conditions in the component under field conditions. A Design Ratio (DR) is then calculated as the ratio of the limiting performance of the component based on laboratory tests to the actual performance calculated for field conditions. Minimum values for DR are recommended for each design procedure. Specific geosynthetic material properties are required to determine the DR in each design procedure. A suggested range of values, based on available data, is presented for each material property used. Additionally, a summary of the test procedures in evaluating each specific material property is provided in the manual. Relevant standards for each test are referenced when available. (Author's abstract)
W90-03762

TECHNICAL SUPPORT DOCUMENT: INCINERATION OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136592. Price codes: A99 in paper copy, A01 in microfiche. 1988. 670p, 19 fig, 14 tab, 37 ref, 6 append.

Descriptors: *Waste treatment, *Wastewater treatment, *Waste management, *Waste disposal, *Incineration, *Sludge disposal, Wastewater disposal, Regulations, Hydrocarbons, Risk assessment, Arsenic, Cadmium, Chromium, Nickel, Lead, Heavy metals.

Incineration is not technically a sludge disposal or use method, but rather a treatment method that converts sludge into an ash, which is then disposed of or used. Because sludge incineration drastically reduces the volume and mass of residual solid materials, it has traditionally been regarded as a disposal method. Incineration is the only thermal process widely used today. Currently applied to 20% of the nation's wastewater sludge, incineration has proved to be an effective sludge disposal technique. A significant part of the process to develop proposed regulations for sewage sludge incineration was formulating the methodology to evaluate the risk of incinerator emissions. The risk methodology addresses the health risks associated with sludge incineration practices. It contains information on the pathway evaluated, the databases that provided information on sludge incinerator facilities, the modeling techniques applied, the exposure criteria and assessment, and a sample calculation. It is structured to allow for the calculation of technical guidelines for sludge incineration, based on the potential for health or environmental impacts. The numeric limits for metals and total hydrocarbons are based, in part, on risk-specific doses (RSD). For a given pollutant, an RSD is the maximum allowable annual increase in ground-level ambient air concentration when sewage sludge is incinerated. RSD values are set independently of any background concentrations. The operation of a sewage sludge incinerator involves the interrelation of a number of operating variables that must be controlled to ensure satisfactory operation and adequate control of air emissions. The major operating variables for sludge incinerators are: combustion and operating temperatures, excess air rate, sludge quality and feed rate, and air pollution control system operating parameters. Each of these variables can have a profound impact on the quantities and quality of emissions from sludge incinerators. The most direct procedure for selecting appropriate limitations for each relevant variable is to test incinerator systems and characterize the acceptability of emissions. The ranges of the operating parameters observed during the tests can then be used to set limits. No testing, however, is performed on sludge incinerators that can demonstrate compliance with the sludge pollutant concentrations when using the reasonable worst-case pollutant control efficiencies for metals. (Lantz-PTT)
W90-03766

LIMITED DEGRADATION AS A GROUNDWATER QUALITY POLICY.
Army Armor Center, Fort Knox, KY.
For primary bibliographic entry see Field 5G.
W90-03774

ABANDONED WELLS, INJECTION WELLS, AND SALTWATER INJECTION: POLICY IMPLICATIONS.
Texas Water Quality Board, Austin. Geological Services Section.
J. W. Mullican.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 30-34.

Descriptors: *Abandoned wells, *Underground waste disposal, *Disposal wells, *Water pollution sources, *Water pollution control, *Waste disposal, *Injection wells, *Saline water, *Water pollution prevention, *Public policy, Texas, Injection Well Act, Disposal Well Act, Permits, Groundwater pollution, Oil wastes, Water rights, Water law, Brine disposal.

Subsurface injection of aqueous wastes has existed in Texas for over 40 years. In order to assure the protection of groundwater from the injection of wastes into the subsurface through disposal wells, the Texas legislature, in 1961, enacted the Injection Well Act, which was later amended as the Disposal Well Act and codified in the Texas Water Code. This statute prescribes the permitting system for subsurface disposal of industrial and municipal wastes and produced salt water in Texas. In accordance with the Act, injection of industrial and municipal wastes into subsurface strata is regulated by the Texas Water Quality Board (TWQB) and the Texas Railroad Commission, with the latter being responsible for wastes resulting from oil and gas drilling or producing activities. Before a permit is issued by the commission for subsurface disposal of produced salt water, an evaluation by the TWQB staff is made to assess groundwater implications. The TWQB, in administering its responsibilities under the Act, believes that subsurface injection is a practical and feasible method of disposal of certain waste when the overall project is properly designed, constructed, operated, and monitored. State law allows injection only if: (1) the installation is in the public interest; (2) no existing rights will be impaired; and (3) with proper safeguards, both ground and surface fresh waters can be adequately protected from pollution. Since the first waste disposal well permit was issued in Texas in 1961, a total of 132 permits have been issued for industrial and municipal injection wells. Nearly 40 billion gallons of waste have been disposed of into these wells with no known contamination of fresh or usable quality groundwater. (See also W90-03771) (Lantz-PTT)
W90-03776

IMPOUNDMENTS FOR LIQUID WASTES: POLICY IMPLICATIONS.
Maryland Water Resources Administration, Annapolis.
A. Schiffman.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 40-46.

Descriptors: *Waste storage, *Water pollution prevention, *Waste disposal, *Wastewater lagoons, *Industrial wastewater, *Reservoirs, *Liquid wastes, *Regulations, Public policy, Organic solvents, Safe Drinking Water Act, Resource Conservation and Recovery Act, Heavy metals.

A public policy for impoundments (pits, ponds, and lagoons) is self-evident--impoundments should work for intended purposes without damaging the environment. The 'environment ' of interest here is groundwater; however, ground and surface waters are inseparable, especially where impoundments are concerned. For groundwater, these issues are being addressed in two recently enacted federal laws: the Safe Drinking Water Act (P.L. 93-523), which deals with the protection of underground sources of drinking water; and the Resource Conservation and Recovery Act (P.L. 94-580), which deals with hazardous wastes. Poison pits which are used to dispose of hazardous wastes (such as organic solvents and plating waste containing Pb, Cd, Ni, CN, As and Cr), industrial waste treatment lagoons, agricultural impoundments, sewage treatment lagoons (oxidation ponds), sediment control impoundments, and miscellaneous impoundments, are examples of the various waste disposal impoundments discussed in this paper. (See also W90-03771) (Lantz-PTT)
W90-03778

LAND APPLICATION OF WASTEWATER AND RESIDUALS: POLICY IMPLICATIONS.
Martin (A. W.) Associates, Inc., King of Prussia, PA.
G. H. Emrich.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 75-W90, 7 fig, 4 tab, 10 ref.

Descriptors: *Water pollution control, *Land disposal, *Wastewater disposal, *Sludge disposal, *Groundwater pollution, *Public policy, Overland flow, Infiltration, Spray irrigation, Nutrients, Site selection, Groundwater quality, Water pollution prevention, Monitoring, Mixing, Wastewater treatment, Municipal wastewater, Surface-groundwater relations.

The three basic methods of land application are (1) overland flow, (2) infiltration/percolation, and (3) irrigation. Spray irrigation is the predominant application method used today. It involves the application of effluent to the land for treatment and as a means of returning necessary nutrients to plants. The primary consideration in selecting a site for spray irrigation is the prevention of adverse effects to surface and groundwater quality. The criteria to be evaluated include the soils, geology, and groundwater conditions at the proposed site. A critical point is the decision as to where the groundwater system will be sampled for monitoring. Unless a mixing zone is allowed for groundwater discharges, many land-treatment systems may be eliminated from consideration. Treatment of wastewater by conventional systems generates significant amounts of residuals or sludges. There has been a recent movement to increase the amount of residues that are disposed of onto the land. Public policy or concern for land disposal of sludges has been minimal except for large municipal projects. Although no distinct policy on groundwater quality protection from land application has yet been articulated, the existing state policies can be assessed when reviewing the operation of land-disposal systems. Land disposal and groundwater quality must be considered together. (See also W90-03771) (Lantz-PTT)
W90-03781

UNDERGROUND INJECTION PROGRAM UNDER THE NATIONAL SAFE DRINKING WATER ACT.
New Mexico State Univ., Las Cruces.

For primary bibliographic entry see Field 5G.
W90-03782

STATE APPROACH TO GROUND-WATER QUALITY PROTECTION: THE ILLINOIS EXPERIENCE.
Illinois State Environmental Protection Agency, Springfield. Div. of Land Pollution Control.
For primary bibliographic entry see Field 5G.
W90-03785

ONSITE WASTEWATER DISPOSAL.
New Mexico Environmental Improvement Agency, Santa Fe.
R. J. Perkins.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 251 p.

Descriptors: *Wastewater disposal, *On-site wastewater treatment, *Wastewater treatment, Septic tanks, Site selection, Domestic wastes, Regulations.

Failed onsite household wastewater disposal systems are becoming an increasing problem over much of the country as homes are constructed in rural areas unsuitable for conventional onsite systems. The homeowner who puts in an expensive but 'environmentally responsible' system may be throwing money down the drain. The land developer who sells lots in these areas without providing a warning to consumers may spend some time in court. The book presents methods of proper septic system practices suited to a broad range of site conditions, and the reasons for using them. Conventional systems discussed include deep absorption trenches, seepage pits, cesspools, and leaching chambers. Low impact systems include evapotranspiration, holding tanks, composting toilets, grey water systems, and disinfection. Potential problems, both with the system components and the people who regulate septic systems, are described and potential solutions provided. Experience throughout the U.S., with respect to lot size for onsite wastewater disposal, indicates that at least a 3/4 acre lot is needed and that a 1-acre lot is more adequate. (Lantz-PTT)
W90-03811

LOW TEMPERATURE STRIPPING OF VOLATILE COMPOUNDS.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5G.
W90-03844

BIOTECHNOLOGICAL ADVANCES IN PROCESSING MUNICIPAL WASTES FOR FUELS AND CHEMICALS.
For primary bibliographic entry see Field 5D.
W90-03850

NUTRIENT REQUIREMENTS FOR ANAEROBIC DIGESTION.
Drexel Univ., Philadelphia, PA.
R. E. Speece, and G. F. Parkin.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 195-221. 7 fig, 58 ref.

Descriptors: *Wastewater treatment, *Waste treatment, *Anaerobic digestion, *Sludge digestion, *Nutrient requirements, *Biodegradation, Limiting nutrients, Municipal wastewater, Trace elements, Volatile acids, Acetates, Propionates, Iron, Cobalt, Nickel, Iron.

The anaerobic digestion process was initially engineered for domestic wastewater sludges. These sludges generally have been assumed to inherently provide all possible nutrients required for the growth of all members of the microbial ecosystem responsible for anaerobic digestion. For the loading rates and solids retention times in common practice, this assumption appears to be validated in most cases by the fact that the process operates satisfactorily without any additional supplementation of nutrients. However, even with domestic sludges, malfunctioning of the digestion process has been reported. In addition, there is evidence that present design and operational practices may have been forged by existing nutrient bioavailability limitations within domestic wastewater sludges. As a case in point, stimulation of the acetate and propionate utilization rate by up to 100% over a control was observed in eight out of thirty municipal sludge digester samples supplemented with one or more of the trace metals iron, cobalt, and/or nickel. A second case in point is that iron supplementation to a municipal sludge digested having a chronically high volatile acids concentration of about 4,000 mg/l, resulted in a reduction to 400 mg/l within ten days. Municipal solid wastes are less nutritionally balanced than domestic wastewater sludges. Therefore, even more consideration must be given to assure that nutrient bioavailability is not limiting the overall process of anaerobic digestion of municipal wastes. (See also W90-03850) (Author's abstract)
W90-03863

EFFECTS OF THE ADDITION OF PROPIONATE AND BUTYRATE TO THERMOPHILIC METHANE-PRODUCING DIGESTERS.
Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.
J. M. Henson, F. M. Bordeaux, and P. H. Smith.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 235-246. 7 fig, 2 tab, 8 ref.

Descriptors: *Wastewater treatment, *Anaerobic digestion, *Sludge digestion, *Methane, *Butyrates, *Propionates, Acetates, Comparison studies.

The effects of increased levels of propionate and butyrate on thermophilic bench-top digesters were studied by continuous infusion of these fatty acids, in addition to the regular daily feed, into 3.6 liter digesters. When butyrate was added at the rate of 10 micromol/ml sludge per day, it did not accumulate. The production of biogas (methane and carbon dioxide) increased by 150%. Percent methane in the biogas increased from 56% to 63%. Acetate and propionate concentrations in the sludge increased from 4 to 35 micromol/ml and 0.5 to 3.3 micromol/ml, respectively. When the addition of butyrate was increased to 15 micromol/ml sludge per day, digestion remained stable with elevated concentrations of acetate (150 micromol/ml sludge) and propionate (25 micromol/ml sludge). Daily production of methane was 5.2 liters versus 3.2 liters in a control digester. Butyrate accumulated to only 10% of the cumulative added butyrate. A second thermophilic digester was infused with propionate at the rate of 10 micromol/ml sludge per day. Propionate accumulated in this digester parallel to the total propionate added for 40 days (two hydraulic detention times). Propionate concentrations then decreased until they reached about 30% of the total added propionate at day 100. Biogas production and methane production was only slightly higher than control digesters. (See also W90-03850) (Author's abstract)
W90-03865

GASIFICATION OF CONCENTRATED PARTICULATE AND SOLID SUBSTRATES BY BIPHASIC ANAEROBIC DIGESTION.
Institute of Gas Technology, Chicago, IL.
For primary bibliographic entry see Field 5D.
W90-03868

NEW CONCEPT FOR THE PRODUCTION OF HIGH-BTU GAS FROM ANAEROBIC DIGESTION.
Gas Research Inst., Chicago, IL.
T. D. Hayes, and H. R. Isaacson.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 355-374. 7 fig, 2 tab, 24 ref.

Descriptors: *Waste treatment, *Wastewater treatment, *Anaerobic digestion, *Methane, *Municipal wastes, *Waste recovery, *Carbon dioxide, Model studies, Solubility, Economic aspects, Separation techniques.

A major economic consideration in the use of anaerobic digestion to convert municipal wastes to pipeline quality methane and commercial grade CO2 is the cost of separating CO2 from the product gas. Physical/chemical processing for upgrading digester gas (55-65% CH4) to a methane gas stream meeting Gas Industry specifications (lesser than or equal to 95% CH4) is costly with estimates typically ranging from $1.50-3.00/mmBtu. Certain anaerobic digestion process designs have the potential of achieving higher methane concentrations in the product gas thereby reducing gas cleanup costs. There are at least three inherent features that make anaerobic digestion uniquely suited to gas separations: 1) the presence of a gas/liquid interface, 2) the phased production and utilization of volatile acids, and 3) the capability of anaerobic bacteria to produce methane against elevated gas pressures. Because the solubility of CO2 in water is many times greater than that of methane, it should be possible to develop reactor schemes capable of achieving efficient separations of these two gases. An equilibrium model has been developed that predicts the methane and CO2 content of the product gas of a steady state digester as a function of commonly-measured influent and effluent parameters. This model, when tested with existing reactor data, showed good correlation between predicted and observed values for methane content. On the basis of the model and the literature, a two-stage, pH-swing/pressure-swing digestion scheme has been conceptualized that has the potential of directly producing pipeline-quality methane and high-grade CO2 from municipal wastes and biomass. (See also W90-03850) (Author's abstract)
W90-03870

BIOCONVERSION OF MUNICIPAL SOLID WASTE AND SEWAGE SLUDGE TO ETHANOL.
Southern Research Inst., Birmingham, AL.
D. R. Coleman, T. J. Laughlin, M. V. Kilgore, C. L. Lishawa, and W. E. Meyers.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 407-417. 4 fig, 3 tab, 8 ref.

Descriptors: *Wastewater treatment, *Waste treatment, *Municipal wastes, *Solid wastes, *Alcohols, Biotransformation, Separation techniques, Hydrolysis, Economic aspects.

A system for the bioconversion of municipal solid waste (MSW) and sewage sludge to ethanol was investigated. The system has three primary components: MSW processing/fractionation, cellulose hydrolysis to fermentable products, and fermentation/distillation. The novel pretreatment process developed in this study effectively separated the organic and inorganic fractions of unsorted MSW. The processed material was fractionated into overs, middles, and fines. The overs were primarily bottles and cans. The middles were mostly organic. When recycled through the MSW unit, about 70% of the total mass came out in the fines fraction which was a soggy mass of organic material. The cellulose in the organic fraction was readily hydrolyzed to glucose by enzymatic and acid hydrolysis processes. This material was demonstrated to be fermentable. The overall yield was about 40 gallons of ethanol per ton MSW (as received). Our economic analyses indicate that a plant processing 1500 tons of MSW per day would require a $90,000,000 capital outlay and that the breakeven price of ethanol would be $1.50 per gallon (based on ethanol production alone). (See also W90-03850) (Author's abstract)
W90-03871

CHEMICAL AND MICROBIOLOGICAL ANALYSIS OF AVELEY LANDFILL, ENGLAND.
BioTechnica Ltd., Cardiff (Wales).
J. F. Rees.
IN: Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals. Noyes Data Corporation, Park Ridge, New Jersey. 1987. p 465-474. 4 fig, 2 tab, 8 ref.

Descriptors: *Landfills, *Solid waste disposal, *England, *Land disposal, *Waste treatment, Aerobic digestion, Anaerobic digestion, Methane, Groundwater, Leachates.

Aveley is a very bioreactive landfill as judged by the criteria of gas production rates, leachate composition and refuse solids composition. This is to be expected as the landfill possesses a high water content. However, it is also clear that at Aveley the removal of volatile fatty acids from leachate is well established. This can also be correlated with lower SO4(--) concentrations. In fact, the Aveley leachate is most unusual in containing virtually zero concentration of volatile fatty acids. Aveley temperatures ranging from 37-45 degrees C are also high and suitable for good microbial activity. The early initiation of methanogenesis and the concomitant development of a good quality leachate at Aveley can be accounted for in terms of landfill engineering. Major factors favoring the establishment of this bio-reactive landfill are the following: (1) Refuse placed with minimal intermediate soil cover, (2) Refuse placed in a large operational area so that it was exposed to aerobic conditions at the surface for 9 months to 1 year before being covered with more refuse, (3) The lateral movement of groundwater in the site, and (4) Upward migration of groundwater/leachate from the base of the site. These conclusions are based on various field, lysimeter, and laboratory studies which showed the importance of partial aerobic processes and water movement on the rapid initiation of methanogenesis. (See also W90-03850) (Author's abstract)
W90-03872

STRATIGRAPHY OF THE UNSATURATED ZONE AT THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO.
Geological Survey, Idaho Falls, ID. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03876

STOCHASTIC DESIGN OF WASTEWATER STORAGE FOR LAND APPLICATION.
Texas Univ., Austin. Center for Research in Water Resources.
For primary bibliographic entry see Field 5D.
W90-03892

SOIL PHASE PHOTODEGRADATION OF TOXIC ORGANICS AT CONTAMINATED DISPOSAL SITES FOR SOIL RENOVATION AND GROUNDWATER QUALITY PROTECTION.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5D.
W90-03893

MUNICIPAL SOLID WASTE MANAGEMENT IN GEORGIA, POLICY ALTERNATIVES.
Georgia Univ., Athens. Carl Vinson Inst. of Government.
For primary bibliographic entry see Field 5G.
W90-03895

GEOHYDROLOGICAL RESEARCH IN RELATION TO RADIOACTIVE WASTE DISPOSAL IN AN AGRILLACEOUS FORMATION.
Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
For primary bibliographic entry see Field 2F.
W90-03906

CSO PARTNERSHIP: CTIES JOIN FORCES ON COMBINED SEWERS.
Greeley and Hansen, Camp Springs, MD.
M. M. Oakley, and C. F. Foster.
Water Environment and Technology, Vol. 1, No. 3, p 408-411, November 1989.

Descriptors: *Wastewater treatment, *Combined sewer overflows, *Governmental interrelations, *Regulations, Policy making, Storm runoff, National League of Cities, CSO Partnership, Legislation, Management planning, Lobbying.

Combined sewer overflows (CSOs) are a combination of untreated domestic wastewater and stormwater runoff that washes into sewers. CSOs exist in older sewer systems that carry both domestic wastewater and stormwater runoff in the same pipe. During dry weather, properly functioning CSOs carry all the sanitary flow to wastewater treatment plants, but during storms the combined flow may exceed the sewer system and wastewater treatment plant capacity and cause direct discharge of untreated effluent into surface water at overflow points within the system. The CSO Partnership is a group formed under the aegis of the National League of Cities with the aim of achieving flexible regulatory policies to permit dealing with the CSO problem in an affordable manner. The 1988 EPA Needs Survey Report to Congress found that more than 1,100 collection systems around the country, serving approximately 40 million people, have CSOs. At the June 1989 CSO Partnership meeting, a strategy was developed that included the following items: increase membership; educate member cities of the need to develop CSO control plans; identify organizations possibly interested in sharing the lobbying effort; define a strategy for obtaining sufficient funding for CSO control through grants and other means; identify, define, and adopt a position on legislation for CSOs; track legislation related to CSOs and participate in its formulation; identify, define, and adopt a position on the regulation of CSOs and make recommendations to EPA; and develop a mission statement that is consistent with the Partnership's positions on legislation, regulation, and grant funding. (Rochester-PTT)
W90-03954

DISCHARGE OF BACTERIA RESISTANT TO HEAVY METALS FROM SEWAGE EFFLUENT INTO FRESHWATER.
Freshwater Biological Association, Ambleside (England).
R. W. Pickup.
Aqua AQUAAA, Vol. 38, No. 4, p 230-235, August 1989. 3 fig, 2 tab, 25 ref.

Descriptors: *Water pollution effects, *Bacteria, *England, *Heavy metals, *Wastewater disposal, Wastewater treatment, Church Beck, Sulfates, Plasmids, Effluents, Heavy-metal resistance, Lakes, Enterobacter.

Bacteria resistant to 10 micromolar (mM) sulfate were examined in streams originating from an abandoned copper mining area (Church Beck, Coniston Fells, Cumbria, England). Throughout the stream system, low numbers of copper-resistant bacteria were isolated (0-23 colony-forming units/100 ml). These numbers increased 10-fold to 100-fold in the last 200-m section of the stream, at or close to its inflow into Coniston Water. Further examination of these bacteria, and those tentatively identified as being members of the family Enterobacteriaceae, revealed that multiple resistances to heavy metals were common. In some cases the resistance was found to be plasmid-mediated. The increase in resistant bacteria correlated with high numbers of similar bacteria being discharged from a sewage effluent pipe. This may represent a major route for the input of heavy-metal resistance into the lake. (Author's abstract)
W90-03964

DESIGN OF A HYDRODYNAMIC LEACHATE CONTAINMENT SYSTEM.
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
M. D. Haug, D. J. L. Forgie, and S. L. Barbour.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 615-626, October 1989. 20 fig, 14 ref.

Descriptors: *Water pollution control, *Water pollution prevention, *Landfill linings, *Seepage control, *Sanitary landfills, *Water table, *Hydrodynamics, *Leachates, *Influent seepage, Design criteria, Linings, Finite element method, Seepage, Mathematical models, Soil compaction, Sanitary engineering.

This design concept for a case study sanitary landfill on a site would not normally have been approved due to the presence of a high water table. In this design, the base of the landfill was intentionally placed below the water table. A massive 2.5 m wide, 2.5 m high cutoff wall and a 0.3 m thick liner with hydraulic conductivities of approximately 0.5 nm/sec were constructed of recompacted glacial till to limit both groundwater intrusion into the landfill and leachate migration out of the landfill. In this case study, the landfill base was placed below the water table to provide a relatively inexpensive source of cover material and to use the hydrodynamic gradient from the high water table to help contain the leachate. Finite element modeling was performed for the seepage and contaminant transport of alternate designs for lined and unlined landfills, placed above and below the groundwater table. The results confirm a previous, less-sophisticated estimation that placing a lined landfill below the groundwater table has definite advantages in reducing both leachate seepage and contaminant transport. (Author's abstract)
W90-04019

ELIMINATING SURPLUS URBAN SLUDGE BY THE FERTILIZATION OF FORESTS (ELIMINATION DES BOUES RESIDUAIRES URBAINES PAR LA FERTILISATION SYLVICOLE).
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
D. Couillard.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 650-660, October 1989. 4 fig, 8 tab, 41 ref. English summary.

Descriptors: *Waste disposal, *Sludge disposal, *Sludge utilization, *Waste management, *Fertilizers, *Solid wastes, Municipal wastes, Sludge disposal, Forests, Trees.

Governments have initiated wastewater treatment programs to solve the problem of water pollution. The goal is commendable, but the inevitable result is the production of sewage sludge that can be considered waste. If it is buried, incinerated, or discharged into the sea, the problem is not solved, just postponed. Moreover, a potentially useful substance has been wasted. The only promising solution is the transformation of sewage sludge into fertilizers. This study shows that sewage sludge produced by water treatment plants can be used as an efficient forest fertilizer which increases the size and height of trees. The fertilization of larch trees in greenhouses using anaerobic sludge from the Valcartier Wastewater Treatment Plant resulted in a 300% increase in height and 210% increase in diameter after 119 days. (Author's abstract)
W90-04020

EXPLANATION FOR THE APPARENT LOSSES OF METALS IN A LONG-TERM FIELD EXPERIMENT WITH SEWAGE SLUDGE.
Rothamsted Experimental Station, Harpenden (England). Inst. of Arable Crops Research.
S. P. McGrath, and P. W. Lane.
Environmental Pollution ENPOEK, Vol. 60, No. 3-4, p 235-256, 1989. 7 fig, 4 tab, 30 ref.

Descriptors: *Sludge disposal, *Soil contamination, *Heavy metals, *Model studies, *Leaching, Path of pollutants, Soil profiles, Accumulation, Soil horizons, Zinc, Cadmium, Copper, Nickel, Chromium, Lead.

Large losses of metals applied to soil in metal-contaminated sewage sludge have been reported. The potential pathways of loss, including lateral movement from treated plot areas, have not been examined. A field experiment, which started in 1942, was investigated to determine the amount of lateral movement of zinc, cadmium, copper, nickel, chromium and lead due to conventional cultivation processes. A two-dimensional dispersion model (i.e. movement of soil due to cultivation) fitted well to the observed movement of metals, and gave coefficients for movement of 0.24 and 0.13 sq m per tillage operation in dimensions parallel or perpendicular to the direction of ploughing, respectively. For testing purposes, the model was

used to predict the concentrations of metals in specific areas of a plot or average concentrations for whole plots at different points in time. The concentrations measured in soil samples agreed well with the predicted values. Finally, the model was also used to estimate the proportion of the metal load applied between 1942 and 1961 that remained in the 0-27 cm cultivated layer in 1985. About 80% was accounted for: this large recovery is of great relevance to the long-term disposal of metal-contaminated wastes to land. Detailed analyses of soil profile samples showed that approximately 1% of the metals applied had moved 3.5 cm below the plough layer or less, but there was no evidence of accumulation of metals in deeper horizons down to 46 cm. These results are discussed in relation to the other potential losses of metals in the experiment. (Author's abstract)
W90-04044

DEWATERING CHARACTERISTICS OF ACTIVATED SLUDGES AND EFFECT OF EXTRACELLULAR POLYMER.
Osaka Univ. (Japan). Faculty of Engineering.
For primary bibliographic entry see Field 5D.
W90-04057

COMPUTER PROGRAM DESIGN FOR LAND TREATMENT SYSTEMS.
Clemson Univ., SC.
R. K. White, and A. Jantrania.
Biocycle BCYCDK, Vol. 30, No. 10, p 66-67, Oct 1989.

Descriptors: *Land disposal, *Waste disposal, *Sludge utilization, *Computer programs, Municipal Sludge Land Application eXpert System, Municipal wastes, Agriculture.

Expert Systems is a computer program that has built into it the knowledge and capabilities to emulate the problem solving skills of a human expert in a specific domain. Expert Systems can be updated on a regular basis, for example, to reflect changes in regulations that follow the current EPA review of beneficial sludge use. Municipal Sludge Land Application eXpert System (MuSLAXS) is an expert system developed for site assessment and design analysis of municipal sludge application on agricultural land. The system has knowledge on the technical and regulatory aspects of sludge land application and an understanding of soil-plant systems for South Carolina. It can be effectively used outside that state with modifications to incorporate specific regulations on land treatment and soil and crop database. MuSLAXS will calculate the sludge application rate based on nitrogen requirements of the crop. It determines annual loading of heavy metals at the agronomic rate and compares the annual loading of heavy metals against the maximum allowed, based on the soil assimilative capacity. If the annual loading of all metals of concern are within 10% of the maximum cumulative limit, then it uses the agronomic rate to calculate the rest of the design parameters. If the annual loading of any of the metals exceeds the limit, then it determines which metal or metals are applied in excess of the annual application limit, by what percentage the metal content of the sludge should be reduced in order to allow the sludge application at the agronomic rate, and by what percent the agronomic rate of the sludge application should be reduced to limit the heavy metal loadings. (Mertz-PTT)
W90-04086

HEAVY METAL CONCENTRATIONS DURING TEN YEARS OF SLUDGE TREATMENT TO AN OLD-FIELD COMMUNITY.
Indiana Univ., Bloomington. School of Public and Environmental Affairs.
M. B. Levine, A. T. Hall, G. W. Barrett, and D. H. Taylor.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 411-418, October-December 1989. 5 fig, 2 tab, 32 ref. USEPA grants R-807370-01 and R-812385-01.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Sludge disposal, *Heavy metals, *Cadmium, *Zinc, *Lead, *Copper, Sludge.

Heavy metal concentrations were determined in three trophic levels of an old-field community treated for 10 consecutive years with sewage sludge. Cadmium concentrations were highest each year in soils, vegetation, meadow vole livers, and earthworms from sludge-treated plots. Mean Cd concentrations in sludge decreased from 59.0 mg/kg in 1978 to 19.8 mg/kg in 1987, whereas Cd concentrations in soil increased from 1.13 mg/kg in 1979 to 1.94 mg/kg in 1987. Plant species in sludge plots had significantly higher Cd concentrations than those collected from fertilizer treated or control plots. No yearly increase in Cd content was observed in meadow vole livers or kidneys. Cadmium concentrations in earthworms were significantly greater in 1981 than in 1987. Copper concentrations were highest in soils, giant foxtail, and earthworms from sludge-treated plots. Mean Cu concentrations in sludge ranged from 320.0 mg/kg in 1978 to 380.6 mg/kg in 1984. Copper concentrations in soil ranged from 14.7 mg/kg in 1979 to 36.9 mg/kg in 1986. Vegetation in sludge plots concentrated Cu less than vegetation in fertilizer or control plots. Cu concentrations in meadow vole liver and kidney decreased between 1978 and 1987. Copper concentration in earthworms ranged from 17.1 mg/kg in 1981 to 23.0 mg/kg in 1987. Although Pb concentrations in sludge declined between 1978 and 1987, mean Pb concentrations in soil increased between 1979 and 1986. However, only giant foxtail in sludge-treated plots significantly concentrated Pb. Mean Pb concentrations in earthworms ranged from 8.06 mg/kg in 1986 to 16.8 mg/kg in 1987. Mean Zn concentrations in sludge ranged from 865.8 mg/kg in 1987 to 1281.0 mg/kg in 1984. Zinc concentrations in soils increased between 1979 and 1987. Zinc concentrations in earthworms decreased between 1981 and 1987. The detritivore trophic level bioconcentrated heavy metals more than producer or primary consumer levels. (Mertz-PTT)
W90-04100

BEHAVIOR OF AROMATIC SURFACTANTS AND PCBS IN SLUDGE-TREATED SOIL AND LANDFILLS.
Venice Univ. (Italy). Dept. of Environmental Science.
A. Marcomini, P. D. Capel, T. Lichtensteiger, P. H. Brunner, and W. Giger.
Journal of Environmental Quality JEVQAA, Vol. 18, No. 4, p 523-528, October-December 1989. 2 fig, 2 tab, 36 ref.

Descriptors: *Sludge disposal, *Landfills, *Biodegradation, Organic carbon, Surfactants, Polychlorinated biphenyls.

The aromatic surfactant linear alkylbenzenesulphonate (LAS) and the refractory biointermediates of nonlyphenol polyethoxylates, namely nonylphenol, nonylphenol monoethoxylate and nonylphenol diethoxylate, together with polychlorinated biphenyls (PCBs) and organic carbon, were determined in sludge-treated soil at 19 time intervals during a 1-year period after sludge application. The initial concentrations of LAS nonlyphenol, nonlyphenol monoethoxylate, and nonylphenol diethoxylate in the amended soil were 45, 4.7, 1.1 and 0.1 mg/kg (dry weight); the residual mean concentrations, 320 days after the last sludge application were 5 mg/kg for LAS 0.5 mg/kg for nonlypnenol, 0.1 for nonlyphenol monoethoxylate, and 0.01 mg/kg for nonylphenol diethoxylate. All of the aromatic surfactants demonstrated a very fast decrease in concentrations (greater than 80% within the first month), presumably due to biodegradation, but all of them exhibited a residual concentration in the soil after 320 days. Total PCBs and organic carbon showed no significant soil concentration changes, within the error of analysis, over this same 1-year period. The pattern of PCBs congeners also demonstrated no substantial changes, indicating that they all behave very similarly. The LAS and PCBs were also measured in samples from dated ponds of four sludge-only landfills that were in use at different times over the past 30 years. The increase in the use of LAS and decrease in the open use of PCBs was reflected in the sludge pond concentrations at one site where there was a continuous record from 1972 to 1986. (Author's abstract)
W90-04109

CONSIDERATIONS FOR CAPPING SUBAQUEOUS DREDGED MATERIAL DEPOSITS.
Coastal Planning and Engineering, Inc., Sarasota, FL.
C. L. Truitt, J. E. Clausner, and T. N. McLellan.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 115, No. 6, p 741-759, Nov 1989. 5 fig, 1 tab, 34 ref, append.

Descriptors: *Dredging wastes, *Waste disposal, *Ocean dumping, Capping, Design criteria, Spoil banks.

Capping is the controlled, accurate placement of contaminated dredged material at a disposal site that is covered by a cap of clean isolating material. Capping projects are typically categorized as either level-bottom placement or contained aquatic disposal. Field experience with subaqueous capping is limited, but 11 sites have been identified where the technique has been applied. Site selection considerations for capping projects are similar to those for any open-water disposal. At least five considerations can be identified that are important in evaluating the engineering acceptability of a proposed open-water dredged material disposal site: bathymetry, currents, average water depths, salinity/temperature stratifications, and operational requirements such as location, distance, surface sea state, etc. The design of the cap requires a two-fold approach. It must result in a capping layer with properties and thickness such that it functions as an adequate isolating seal, yet the layer must remain unbroken and resist resuspension and transport by the bottom shear stress at the site. Equipment and techniques for placing both dredged material and cap should consider the objectives of control and accuracy. Technologies such as the submerged diffuser are available to provide controlled accurate placement and to accomplish the additional benefit of isolating the material from the water column during descent. Monitoring is an important aspect of construction verification and site management. (Mertz-PTT)
W90-04111

DEVELOPING ALTERNATIVES TO LANDFILLS.
G. A. Davis.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 45-49, 1 tab.

Descriptors: *Landfills, *Groundwater pollution, *Water pollution prevention, *Waste management, *Hazardous wastes, Regulations, Education, California, Management planning, Recycling, Detoxification, Denmark, West Germany, Austria, Federal jurisdiction.

There are two aspects to the threat of hazardous waste to groundwater: old disposal sites and new sites. New sites area a problem because 80%-90% of all hazardous waste is put in the ground. The Resource Conservation and Recovery Act (RCRA) regulates the generation, transport, storage, treatment, and disposal of hazardous waste. Regulations have been adopted that prescribe standards for treatment, storage, and disposal facilities. In California there is a shift from land disposal to alternatives that recycle, detoxify, and destroy hazardous waste. Alternatives to land disposal are not futuristic technologies. They are being used today in the United States, but not to the extent they are being used elsewhere. For example, the United States still dumps more than 90% of its waste in the ground, but West Germany dumps only 40% into the ground without treatment. In Denmark, more than 90% of all hazardous waste is treated before being disposed of in the ground. Government has four basic approaches to promote alternatives to land disposal: (1) it can undertake the activity itself; (2) it can coerce industry to do the activity through regulation; (3) it can encourage or discourage the activity by offering financial incentives or disincentives and by offering

technical assistance; or (4) it can promote the activity through education. In Europe, all four of these methods have been used to implement recycling and treatment technologies. (See also W90-04221) (Lantz-PTT)
W90-04225

COMPLETE DOCUMENTATION OF THE SYSTEM/USER MANUAL FOR THE RISK ASSESSMENT MODELS FOR LAND APPLICATION OF MUNICIPAL SLUDGES (RAMMS VERSION 3.0): VOLUME I.
Science Applications, Inc., McLean, VA.
For primary bibliographic entry see Field 7B.
W90-04248

AT INTENSIVE SURVEY OF THE SUGAR CREEK BASIN, CRAWFORD COUNTY, ILLINOIS, 1986.
Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
For primary bibliographic entry see Field 5B.
W90-04254

LAND APPLICATION AND DISTRIBUTION AND MARKETING OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136576. Price codes: A22 in paper copy, A01 in microfiche. Technical Support Document, 1988. 499p, 4 fig, 78 tab, 377 ref.

Descriptors: *Land disposal, *Regulations, *Marketing, *Sludge disposal, *Path of pollutants, Pollutant identification, Fate of pollutants, Water pollution effects, Air pollution, Sensitivity analysis, Risk assessment, Soil contamination.

This document provides the technical data and justification supporting one of the proposed regulations--land application--issued under section 305(d) of the Clean Water Act (CWA). Section 2 of this document outlines land application options, sludge characteristics, and previous experience with land application of sludge. Section 3 introduces 13 environmental pathways through which sludge pollutants may reach target organisms and the means of quantifying the magnitude of the resultant risk. Section 4 contains the data by which the pollutants of concern in the land application of a sludge were quantified for each pathway as well as the data by which the subsequent fate and transport of these contaminants in air, water, and soil were identified. Photolysis, volatilization, hydrolysis, and other processes were examined for their effects on bioavailability and toxicity to target organisms. Section 5 describes the sensitivity analyses that were used to evaluate the effects of different most-exposed individual (MEI) scenarios for a number of the pathways discussed. Section 6 contains a summary of the pathways selected for distribution and marketing and agricultural use sludge practices as well as justification for inclusion. (Lantz-PTT)
W90-04273

METALS SEPARATION AND RECOVERY.
Illinois Inst. of Tech., Chicago.
For primary bibliographic entry see Field 5D.
W90-04373

USE OF THIOUREA AND THIOACETAMIDE FOR SEPARATION AND RECOVERY OF HEAVY METALS FROM MINERAL TREATMENT WASTE WATERS.
Nevada Univ., Reno.
For primary bibliographic entry see Field 5D.
W90-04374

KINETICS OF CADMIUM AND COPPER COMPLEXATION.
Illinois Inst. of Tech., Chicago.
For primary bibliographic entry see Field 5D.
W90-04381

ECONOMIC FEASIBILITY OF A STATE-WIDE HYDROMETALLURGICAL RECOVERY FACILITY.
ERM-North Central, Inc., Palatine, IL.
R. O. Ball, G. P. Verret, P. L. Buckingham, and S. Mahfood.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 689-708, 2 fig, 8 tab, 23 ref.

Descriptors: *Economic feasibility, *Heavy metals, *Waste recovery, *Separation techniques, *Wastewater treatment, Hazardous materials, Missouri, Copper, Zinc, Chromium, Nickel, Water pollution prevention, Feasibility studies, Wastewater facilities.

Metal separation and recovery from mixed-metal bearing wastes has been demonstrated to be technically feasible, but the economic feasibility of specific applications has not been well documented. A feasibility study for a centralized hazardous waste treatment facility was conducted for the Environmental Improvement and Energy Resources Authority of the State of Missouri. Metals recovery by hydrometallurgical process was selected for detailed evaluation since it could potentially recycle toxic metals, which are the basis for hazardous waste listings in many cases, and would produce a reduced quantity of non-hazardous residuals for disposal. The process selected for analysis was developed by Montana College of Mineral Science and Technology for a US EPA research project, and included a successful pilot test assembly. This process included the following major unit processes: metal hydroxide dissolution, iron removal, solid/liquid separation, copper recovery, zinc recovery, chromium recovery and nickel recovery. The estimated quantities of appropriate wastes for a Missouri hydrometallurgical facility were obtained from hazardous waste manifest data. Five criteria were used to determine economic feasibility: commercial proven technology, favorable regulatory setting, sufficient market demand for the facility, financially self-supporting, and minimal environmental liability. Considering the state of development of the facility and the considerably lower cost for alternative disposal techniques, a hydrometallurgical facility would not be economically feasible for the State of Missouri. However, since the facility would have substantial environmental merits, it was recommended that the State encourage development. (See also W90-04370) (VerNooy-PTT)
W90-04389

RECOVERY OF ALUMINUM AS ALUMINUM SULFATE FROM ALUMINUM ANODIZING SLUDGE.
Georgia Inst. of Tech., Atlanta.
For primary bibliographic entry see Field 5D.
W90-04390

STUDIES OF THE UPTAKE OF HEAVY METALS BY ACTIVATED SLUDGE.
Metropolitan Sanitary District of Greater Chicago, IL.
For primary bibliographic entry see Field 5D.
W90-04391

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT: MUNICIPAL, INDUSTRIAL AND AGRICULTURAL.
For primary bibliographic entry see Field 5D.
W90-04392

HYDROLOGIC FACTORS IN WETLAND WATER TREATMENT.
Michigan Univ., Ann Arbor. Wetlands Ecosystem Research Group.
For primary bibliographic entry see Field 5D.
W90-04395

POTENTIAL USE OF CONSTRUCTED WETLANDS TO TREAT LANDFILL LEACHATE.
Geological Survey, Tacoma, WA.
For primary bibliographic entry see Field 5D.
W90-04466

NATURAL RENOVATION OF LEACHATE-DEGRADED GROUNDWATER IN EXCAVATED PONDS AT A REFUSE LANDFILL.
South Dakota State Univ., Brookings.
For primary bibliographic entry see Field 5G.
W90-04467

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA): HAZARDOUS WASTES. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5G.
W90-04498

5F. Water Treatment and Quality Alteration

PROCEEDINGS, MISSISSIPPI WATER RESOURCES CONFERENCE.
Mississippi Water Resources Research Inst., Mississippi State.
14-15 March 1989, Jackson, Mississippi. Water Resources Research Institute, Mississippi State Univ., Mississippi State, MS. Conference. Edited by Elizabeth J. Hawkins. 137p.

Descriptors: *Water resources management, *Water management, *Water quality control, *Water supply, *Conferences, *Mississippi, Groundwater quality, Groundwater management, Water distribution, Water requirements, Water use, Water pollution control, Resources management, Management planning, Runoff, Irrigation, Institutions.

This volume contains papers presented at a conference sponsored by the Mississippi Water Resources Research Institute, the Mississippi Bureau of Land and Water Resources, and the Mississippi District Office of the Geological Survey. The papers deal with institutional issues of water management, water quantity and water quality management, basic research, and water supply problems in the state of Mississippi. Subjects of individual papers include groundwater, streamflow and runoff, stream fisheries, water use, and irrigation, among others. (See W90-02709 thru W90-03729) (Friedmann-PTT)
W90-03708

WATER RESOURCES MANAGEMENT PLAN, JACKSON COUNTY, MS.
Waggoner Engineering, Inc., Jackson, MS.
For primary bibliographic entry see Field 6B.
W90-03712

ZEOLITE AMMONIA REMOVAL FROM CATFISH POND WATERS.
Mississippi Univ., University. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W90-03714

WATER QUALITY MANAGEMENT FOR PH CONTROL.
Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
For primary bibliographic entry see Field 5G.
W90-03717

WATER FILTRATION PLANTS: WILL THE STATUS QUO DO FOR THE FUTURE.
Alabama Univ., University.
J. V. Walters, J. B. deGraffenried, and P. C. John.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 71-75. 13 ref.

Descriptors: *Filtration, *Water treatment, *Water treatment facilities, *Future planning, *Municipal water, *Water demand, *Maintenance costs, Feasibility studies, Raw water, Water quality, Waste

disposal, Flocculation, Coagulation, Turbidity, Algae, Color.

The advantages and requirements of high-rate filtration are reviewed for the expanding of an existing public water treatment plant's filtration capacity or for the designing of a new plant. High-rate filtration systems can meet the increasing demands on water treatment plants without the high price. For a conventional water treatment plant, about 65% of the construction cost is for the flocculation and sedimentation units. Therefore, substantial savings can be achieved by the use of high-rate filtration instead of conventional treatment. The method also offers lower operation and maintenance costs due to reduced chemical usage and reduced sludge handling and disposal. The satisfactory use of high-rate filtration requires a good quality raw water supply providing water low in turbidity, algae, and color. Examination of the predictable temporal relationships of turbidity and microscopic-organism concentrations versus demand must be accounted for in the study of the feasibility of a particular version of a high-rate filtration process. Proper coagulation (and possibly flocculation) is essential for optimum high-rate filtration, i.e., the best coagulant, most effective polymer, optimum doses and durations of mixing times, must be determined to produce a pinpoint floc tough enough to resist the greater shear forces created. (See also W90-03708) (Friedmann-PTT)
W90-03722

SAFE DRINKING WATER ACT: AMENDMENTS, REGULATIONS AND STANDARDS.
For primary bibliographic entry see Field 5G.
W90-03730

HISTORICAL DEVELOPMENT OF THE NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
For primary bibliographic entry see Field 5G.
W90-03731

OVERVIEW OF THE CURRENT NATIONAL PRIMARY DRINKING WATER REGULATIONS AND REGULATION DEVELOPMENT PROCESS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
J. A. Cotruvo, and M. Regelski.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 17-28, 5 tab, 10 ref.

Descriptors: *Primary Drinking Water Regulations, *Water treatment, *Regulations, *Drinking water, *Water quality control, Volatile organic compounds, Synthetic compounds, Microorganisms, Lead, Copper, Radioisotopes, Disinfectants, Inorganic compounds, Pesticides, Organic compounds, Safe Drinking Water Act, Carcinogens, Risk assessment.

The promulgation of the National Primary Drinking Water Regulations (NPDWR) follows specific steps. First, the Advance Notice of Proposed Rule Making (ANPRM) is published. It includes what EPA is considering for possible regulation and what is already known about the science and technology of the contaminant, and asks for more information and comments. Second, the EPA, as mandated by the SDWA Amendments, proposes maximum contaminant levels (MCLs), (enforceable standards) and maximum contaminant level goals (MCLGs) (nonenforceable health goals) simultaneously. More public comments are received, and eventually the regulations are finalized. The Office of Drinking Water developed a six-phase schedule that has attempted to parallel the SDWA-specified deadlines: Phase I--Volatile organic chemicals--July 8, 1987; Phase II--Synthetic organic chemicals and inorganic chemicals--June 1989, Microbials and surface water treatment (filtration)--June 1989, and Lead/copper (corrosion by-products)--December 1988; Phase III--Radionuclides--December 1988; Phase IV--Disinfectants and disinfection by-products--June 1989; Phase V--Other inorganic chemicals, synthetic organic chemicals, and pesticides--June 1989; and Phase VI--25 additional chemicals--January 1991. In selecting contaminants for regulation, the most relevant criteria are (1) potential health risk; (2) ability to detect a contaminant in the drinking water; and (3) occurrence or potential occurrence in drinking water. The EPA uses a three category approach for setting maximum contaminant level goals for carcinogens: Category I, strong evidence of carcinogenicity-zero; Category II, equivocal evidence--reference dose (RfD) approach or 0.00001 to 0.000001 cancer risk range; and Category III, inadequate or no evidence from animal studies--RfD approach. (See also W90-03730) (Lantz-PTT)
W90-03732

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR VOLATILE ORGANIC CHEMICALS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W90-03733

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR SYNTHETIC ORGANIC CHEMICALS, INORGANIC CHEMICALS, AND MICROBIOLOGICAL CONTAMINANTS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W90-03734

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR RADIONUCLIDES.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5G.
W90-03735

ISSUES IN DEVELOPING NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR DISINFECTION AND DISINFECTION BY-PRODUCTS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5G.
W90-03736

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR ADDITIONAL CONTAMINANTS TO BE REGULATED BY 1989.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5G.
W90-03737

OFFICE OF DRINKING WATER'S HEALTH ADVISORY PROGRAM.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5G.
W90-03738

COMPLIANCE BY PUBLIC WATER SUPPLY SYSTEMS WITH NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
For primary bibliographic entry see Field 5G.
W90-03739

DRINKING WATER QUALITY AND WATER TREATMENT PRACTICES: CHARTING THE FUTURE.
Massachusetts Univ., Amherst. Div. of Public Health.
E. J. Calabrese, and C. E. Gilbert.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 113-142, 4 tab, 58 ref.

Descriptors: *Drinking water, *Water quality control, *Future planning, *Water quality management, Safe Drinking Water Act, Economic aspects, Inorganic compounds, Water treatment facilities, Regulations, Compliance, Disinfection, Chlorination, Biological pollution, Organoleptic properties, Toxicology, Costs.

Economic analyses have played and will continue to play an influential, if not dominating, role in the final decision by a community with respect to the selection of their drinking water treatment process. Proponents of various technologies such as ozonation, chloride dioxide, granular activated carbon (GAC) adsorption, and other treatments have often presented cost comparisons. However, each system is unique and requires an analysis of its water quality and types of possible treatment options and costing components. Other factors for selecting one option over another include compliance with turbidity, taste and odor, trihalomethane (THM) levels, and disinfection. The emerging toxicology data is beginning to suggest that disinfectant by-products, and the level of residual chlorine in the drinking water, and other factors should also influence the decision making processes of a community. EPA has noted that compliance with drinking water regulations is a problem mostly for small systems (serving < 3300 people). EPA reports that in 1982 the microbiological requirements were not met by 10% of the smaller systems. Between 1500-3000 systems exceeded maximum contaminant levels (MCLs) for certain inorganic contaminants, with the problems centering on arsenic, barium, lead (from pipe or solder corrosion), fluoride, and nitrate. The inability of small community systems to pay for the needed improvements in order to achieve compliance with the primary drinking water regulations is an important cause of the high noncompliance rates. The weighing of the health risks and compliance costs is a difficult task Consequently, EPA needs to develop flexible approaches for achieving the goals of the Safe Drinking Water Act, especially in the case of small systems. (See also W90-03730) (Lantz-PTT)
W90-03740

DRINKING WATER HEALTH ADVISORY: PESTICIDES.
For primary bibliographic entry see Field 5G.
W90-03747

GRANULAR ACTIVATED CARBON: DESIGN, OPERATION AND COST.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, and B. W. Lykins.
Lewis Publishers, Inc., Chelsea, Michigan. 19W90. 342 p.

Descriptors: *Design criteria, *Activated carbon, *Drinking water, *Water treatment, *Granular activated carbon, *Costs, Synthetic compounds, Trihalomethanes, Organic compounds, Economic aspects, Regeneration.

A summary is presented of design, cost, and performance information on the application of application of granular activated carbon (GAC) in drinking water based on field-scale experience. A brief history of the development of regulations for control of synthetic organics in drinking water is presented. The use of GAC in other countries is discussed and various design concepts for the unit operations that make up the GAC process are explored. Included in the book are chapters that present information from field-scale research projects dealing with the performance of virgin and reactivated carbon; problems and limitations of carbon reactivation systems; and use of carbon for removing trihalomethanes, trihalomethane precursors, and synthetic organics. The last chapter provides cost equations and comparative cost studies for full-scale application of GAC. (Lantz-PTT)
W90-03770

ARTHUR YOUNG GUIDE TO WATER AND WASTEWATER FINANCE AND PRICING.
Young (Arthur) and Co., Charlotte, NC.
For primary bibliographic entry see Field 6C.
W90-03810

HEALTH EFFECTS OF DRINKING WATER TREATMENT TECHNOLOGIES.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 146 p.

Descriptors: *Public health, *Drinking water, *Water treatment, *Disinfection, Chlorination, Chlorine, Chloramine, Trihalomethane, Organic compounds, Corrosion, Granular activated carbon, Air stripping, Water quality.

A legitimate public health concern has been raised about the potentially harmful by-products of disinfection. Since alternative disinfectants to chlorine are expected to be increasingly adopted in the United States, high priority is being given to further characterizing the chemical and toxicological nature of their by-products, particularly those of ozone. Because chloramine is a significantly weaker disinfectant than chlorine, preformed chloramination should not be used as a method of primary disinfection, especially when viruses and/or parasites are a concern, but its use as a secondary disinfectant is acceptable. When free chlorine (chlorine that has not reacted with other compounds) is employed as the primary disinfectant and the potential for trihalomethane (THM) formation is significant, water utilities should maintain a slight residual of free chlorine above that needed to oxidize nitrogen and then add ammonia. This technique results in monochloramine formation and reduces the potential for forming THM and other by-products. An effort should be made to remove significant levels of organic precursors prior to disinfection. This improves the efficiency of disinfection, reduces the formation of disinfection by-products, and may obviate the need for additional treatment to remove excess by-products. Corrosion control is important in many public and private water systems given: (1) the health concerns associated with corrosion by-products (especially lead), (2) its enormous impact on distribution system replacement, and (3) the effect of corrosion on the esthetic quality of water. Granular activated carbon or air stripping is highly recommended where high removal rates are necessary to meet standards for volatile organic compounds. Air stripping is also known to be effective in removing radon. (Lantz-PTT)
W90-03829

LEAD AND CHROMIUM CONCENTRATIONS IN THE POTABLE WATER OF THE EASTERN PROVINCE OF SAUDI ARABIA.
King Faisal Univ., Damman (Saudi Arabia). Coll. of Medicine and Medical Sciences.
For primary bibliographic entry see Field 5B.
W90-03940

PRETREATMENT FOR RAW WATER STORAGE.
Water Storage Corp., Werkendam (Netherlands).
G. Oskam, and L. Lijklema.
Aqua AQUAAA, Vol. 38, No. 1, p 7-15, February 1989. 9 fig, 4 tab, 19 ref.

Descriptors: *Raw water, *Water storage, *Reservoirs, *Water treatment, *The Netherlands, Eutrophication, Biomass, Water quality control, Precipitation, Chemical water treatment, Phosphorus, Suspended solids, Underground storage, Lake Ijssel, De Grote Rug Reservoir, Algae, Mixing.

Two types of storage can be distinguished: open storage reservoirs and underground storage via artificial recharge. Problems encountered in reservoirs are often due to eutrophication, resulting in a high biomass of algae and the deterioration of water quality. For underground storage, clogging of recharge wells or infiltration ponds by suspended solids often is a major problem. Simple methods for control of eutrophication in reservoirs are in-reservoir precipitation of phosphorus (shallow reservoirs) and algal control by artificial circulation of deep reservoirs (light limitation). Objectives of pretreatment before artificial recharge are the removal of suspended solids and/or phosphorus. Experiences with protection of raw water quality in The Netherlands are described, including: adding iron salts to the inlet water of De Grote Rug Reservoir, water quality control options in the Biesbosch Reservoirs (air injection for reservoir mixing, control of algal growth through mixing (light limitation), and pretreatment of Lake Ijssel water before underground storage in coastal dunes. The application of phosphorus-precipitating chemicals to the inlet water of shallow hypertrophic reservoirs often is effective for avoiding the mass development of algae, particularly bluegreens. In 'optically deep' reservoirs, artificial mixing provides an efficient and economical way of controlling algal development to moderate levels. With fully-mixed reservoirs, compartmentalization of the reservoir volume leads to increased water-quality improvement during storage. In the dune infiltration case, pretreatment of Lake Ijssel water based on tapered flocculation, lamella sedimentation, and up-flow filtration removes more than 99% of suspended solids. (Rochester-PTT)
W90-03959

PERFORMANCE OF FLUIDIZED PELLET BED SEPARATOR FOR HIGH-CONCENTRATION SUSPENSION REMOVAL.
Hokkaido Univ., Sapporo (Japan). Dept. of Environmental and Sanitary Engineering.
N. Tambo, and Y. Matsui.
Aqua AQUAAA, Vol. 38, No. 1, p 16-22, February 1989. 13 fig, 1 tab, 6 ref.

Descriptors: *Water treatment facilities, *Water treatment, *Chemical coagulation, *Suspended solids, Performance evaluation, Fluidized beds, Aluminum, Pellets.

A new separator with a very short detention time of 3-5 minutes to separate high-concentration suspension of 100-1000 g/cu m in a simple fluidized pellet bed is proposed and described. Coagulation of these high-concentration suspensions is carried out with a minimum of aluminum coagulant and weakly anionic polymers to generate high-density spherical agglomerates (pellets). The agglomerates have one order higher density than ordinary flocs. Separation of coagulated microflocs is accomplished with 'one-by-one attachment mode' contact flocculation onto the pellets. An optimal agitation is given to make dense, spherical pellets. Up-flow velocity of the pellet fluidized bed is 30 cm/min or higher. Through a simple blow-down, excess pellets are withdrawn from the fluidized bed. Dewatering of the pellets sludge proceeds efficiently by simple mesh screening to achieve a moisture content of about 70%. (Author's abstract)
W90-03960

ELIMINATION OF ZOOPLANKTON BY FLOCCULATION AND FILTRATION.
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt, and B. Lusse.
Aqua AQUAAA, Vol. 38, No. 1, p 23-31, February 1989. 11 fig, 3 tab, 14 ref.

Descriptors: *West Germany, *Water treatment, *Flocculation, *Filtration, *Drinking water, Zooplankton, Rotifers, Hydrogen peroxide, Ozone, Ultrasonics, Potassium permanganate, Oxidation, Pilot plants, Wahnbach Reservoir, Aluminum, Cellulose, Sand filters, Manganese, Performance evaluation.

In flocculation and filtration processes, the removal of zooplankton, which should not be present in drinking water, depends on the shape, size, and mobility of the individuals. Large and bulky organisms with large caudal appendages are better retained in the filter than small compact forms. Rotifers can discharge from attaching flocs with the aid of their rotatory organ. To optimize elimination (>90%), an inactivation of these organisms is necessary. In addition to chlorine, which is undesirable because of formation of organochlorides, ozone (1.5-2 mg/l for 1 min), potassium permanganate (0.5-1 mg/l for 15-20 min), and ultrasound (reaction time of a few seconds) all are appropriate. The elimination of rotifers by flocculation and filtration was investigated in a pilot plant at Siegburg, West Germany. Among the procedures tested were filtration or flocculation without aids, algae as filtration aids, cellulose as a filtration aid, incorporation of rotifers into flocculant, inactivation of rotifers with hydrogen peroxide, ozone, or ultrasound, and elimination of inactivated rotifers by flocculation with potassium permanganate. Rotifers like Kellicottia longispina are relatively easily removed, but rotifers such as Notholca caudata are difficult to remove. Suitable methods for removing zooplankton by flocculation and filtration at full scale are: (1) reduction of the grain size of the filtration material to the size and form of the zooplankton organisms (less than or equal 0.5 mm); (2) reduction of the filter pore volume by conditioning of the filter to produce a surface filtration effect, and (3) inactivation of zooplankton and adjacent flocculation with a surplus of flocculant and rapid sand filtration. The experiments were conducted at a pilot plant and verified at full scale at the Wahnbach Reservoir purification plant. A dose of 1 mg/l Al(3+) was sufficient for effective treatment. It was possible to reduce rotifer abundance from 20-300 individuals per liter in raw water to 0-5 per liter in drinking water. The concentration of total manganese in the filtrate was below 20 microgram/l, the residual concentration of aluminum, despite the elevated does in the range of 10-15 microgram/l Al(3+). (Rochester-PTT)
W90-03961

EFFECTS OF ALKALINITY ON THE REACTIVITY OF OZONE TOWARDS HUMIC SUBSTANCES AND MANGANESE.
Omnium de Traitement et Valorisation, Maisons-Laffitte (France). Chemin de la Digue.
H. Paillard, B. Legube, and M. Dore.
Aqua AQUAAA, Vol. 38, No. 1, p 32-42, February 1989. 9 fig, 4 tab, 29 ref.

Descriptors: *Alkalinity, *Raw water, *Water treatment, *Chemical treatment, *Humic acids, *Water treatment, Organic carbon, Drinking water, Manganese, Fulvic acids, Bicarbonates, Ultraviolet light, Chlorination, Process control, Hydrogen peroxide, Hydroxyl radicals.

A laboratory study was conducted on the ozonation of aqueous fulvic acid solutions, with or without manganese, and on raw drinking waters. The results showed that bicarbonate slows the decomposition of ozone in the presence of fulvic acid. This stabilization of ozone favors its direct reaction pathway, leading to a reduction of UV absorbing sites of fulvic acids and to a decrease of organohalide precursors and of chlorine demand. It also explains the better manganese oxidation by ozone when both fulvic acids and manganese are present. However, when the radical oxidation pathway is favored by coupling O3 and H2O2, the scavenging effect of alkalinity on the OH(-) radical partly inhibits the dissolved organic carbon removal from water containing humic substances. (Author's abstract)
W90-03962

DEVELOPMENT OF COMPUTER USAGE IN A UK WATER COMPANY.
North Surrey Water Co., Staines (England).
For primary bibliographic entry see Field 7C.
W90-03963

ROLE OF WATER CONSERVATION AND ITS PROSPECTS FOR THE DEVELOPMENT OF URBAN WATER SUPPLY IN CHINA.
Ministry of Construction, Beijing (China). Dept. of Urban Construction.
For primary bibliographic entry see Field 3D.
W90-03965

WATER MAINS: REHABILITATION AND MATERIALS REVIEW.
WRc Engineering, Swindon (England).
J. De Rosa, and C. Evins.
Aqua AQUAAA, Vol. 38, No. 4, p 246-255, August 1989. 3 fig, 3 tab, 11 ref.

Descriptors: *Materials selection, *Pipes, *Rehabilitation, Water conveyance, Management plan-

ning, Utilities, Water quality control, Materials engineering.

The length of water mains in the United Kingdom has grown steadily over the last 100 years with relatively little replacement of old mains. Approaching the last decade of the century, the nation has underground assets comprising approximately 350,000 km of water mains with an average age of perhaps 45 yr. About 85% of these mains are iron pipes that are subject to corrosion and hence may be associated with structural, hydraulic, and water quality problems. Other pipe materials are also subject to some of these problems. An integrated approach to rehabilitation of this network is described, including: rehabilitation techniques, pipe replacement, selection of pipe materials, the need for rationalization of theuse of pipe materials among differing parts of the system, completing the pipe materials selection manual, choosing pipe materials, pipe material limitations (ductile iron pipe, uPVC pipes), development of a technical selection procedure, and water quality considerations. A technical selection chart for distribution pipe materials was developed. The Water Research Centre has played an important role working with the water utilities to develop relevant investigative procedures and planning strategies. Some techniques, such as network analysis and leakage control, are well established. Others, such as rehabilitation planning and the selection of pipe materials, have been developed more recently. (Rochester-PTT)
W90-03967

EXPERIENCES OF QUALITY CONTROL OF RAW WATER STORAGE RESERVOIRS.
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W90-03968

RESIDUAL ALUMINIUM IN DRINKING-WATER TREATMENT.
Technische Univ. Berlin (Germany, F.R.). Faculty of Environmental Engineering.
M. R. Jekel, and B. Heinzmann.
Aqua AQUAAA, Vol. 38, No. 5, p 281-288, October 1989. 7 fig, 26 ref.

Descriptors: *Water treatment, *Aluminum, *Drinking water, *Solubility diagrams, Hydrogen ion concentration, Chemical reactions, Alum, Chemical water treatment, Calcium, Sulfates, Ions, Chemical coagulation.

The residual concentration of aluminum in drinking water is determined by the solubility of the hydroxide precipitate, which is strongly pH-dependent. Stability and solubility diagrams based on known chemical equilibrium reactions cannot be used directly. To solve this problem, a practical solubility diagram, showing the ranges of residual aluminum as a function of pH in membrane-filtered samples, was derived from jar-test data. This sketch can be applied in water purification with alum as a coagulant, a low content of dissolved organic materials, and for pore sizes of membrane filters in the range 0.05-0.45 micrometer. While sulfate and calcium ions do not influence the residual concentrations significantly, dissolved humic and fulvic acids, especially after pre-ozonation and low alum dosages, can induce excessively high aluminum residuals by surface complexation. (Rochester-PTT)
W90-03969

MANAGING WATER SUPPLY: PUBLIC OR PRIVATE.
Water Training, Tadley Court, Tadley Common Road, Tadley, Basingstoke, Hants RG26 6TB, UK.
D. Hughes.
Aqua AQUAAA, Vol. 38, No. 5, p 289-295, October 1989.

Descriptors: *Training, *Water supply, *Utilities, *Metropolitan water management, Comparison studies, Training, Education.

In a technically driven industry such as water supply, with huge capital investment, the recognition of the qualities of a good manager frequently have been restricted to technical competence. Although functional experts may make good managers, it is now generally accepted that many attributes other than technical ability are required by the modern manager. These qualities may vary according to whether the water supply organization is public or private, but variation probably is in terms of emphasis rather than content. The private water company manager tends to be more visible to customers than the public sector manager. The quality of management required for the effective maintenance of public water supply is discussed under the following headings: how to become a manager (political sensitivity, sensitivity for people, communication, observation and analysis, leadership qualities, and technical and financial background); public or private ownership (the manager's role, the manager's needs, and the difference managerial between public and private); and training. (Rochester-PTT)
W90-03970

TRACE METALS IN THE DRINKING WATER OF BAHRAIN.
Hassan Ahmed Hassan Juma, Environmental Protection Committee, PO Box 26909, Bahrain.
E. Raveendran.
Aqua AQUAAA, Vol. 38, No. 5, p 305-310, October 1989. 3 fig, 3 tab, 10 ref.

Descriptors: *Bahrain, *Drinking water, *Heavy metals, *Trace metals, Public health, Lead, Cadmium, Aluminum, Chromium, Arsenic, Selenium, Iron, Copper, Zinc, Manganese, Nickel, Mercury, Spectrophotometry.

The state of Bahrain comprises a group of islands on the southern side of the Arabian Gulf in the shallow sea between Qatar Peninsula and the coast of Saudia Arabia. The total area is 694 sq km. Drinking-water samples were collected three times during 1987 from all over Bahrain and were analyzed for Pb, Cd, Al, Cr, As, Se, Fe, Cu, Zn, Mn, Ni, and Hg. A random selection of 45 water samples was examined, including raw, finished (blended), and bottled water. Several analytical methods were used in conjunction with a graphite-furnace atomic-absorption spectrophotometer with a computer. Mean levels of each metal (microgram/l) were as follows: Pb, 3.94; Cd, 0.18; Al, 19.56; Cr, 5.28; As, <1.0; Se, <1.0; Fe, 15.52; Cu, 22.08; Zn, 54.37; Mn, 6.27; Ni, < 10.0; and Hg, 0.086. Significant differences from one location to another were observed for Cu and Zn that depended mainly on the water storage and plumbing systems. Concentration of trace metals appear to be quite normal compared to recently accepted World Health Organization values. (Author's abstract)
W90-03972

REACTIONS OF OZONE WITH D-GLUCOSE IN OXYGENATED AQUEOUS SOLUTION: DIRECT ACTION AND HYDROXYL RADICAL PATHWAY.
Max-Planck-Inst. fuer Strahlenchemie, Muelheim an der Ruhr (Germany, F.R.).
M. N. Schuchmann, and C. von Sonntag.
Aqua AQUAAA, Vol. 38, No. 5, p 311-317, October 1989. 2 fig, 1 tab, 25 ref. Bundesministerium fuer Forschung und Technologie Project 02-WT 8720.

Descriptors: *Oxidation, *Ozonation, *Glucose, *Water treatment, Hydroxyl radicals, Chemical reactions, Organic matter, Degradation products.

High molecular weight carbohydrates originating from algae are ubiquitous organic contaminants of surface waters. These substances are not readily metabolized by microorganisms while their low molecular weight degradation products favor bacterial regrowth. The reactions of ozone with D-glucose were used to study the effectiveness of ozone in reducing the load of organic matter in raw water and to discriminate between the direct and indirect mode of ozone action. The oxidation of D-glucose in oxygenated aqueous solution at pH 6.5 by ozone yields mainly D-gluconic acid, D-arabino-hexosulose, D-ribo-hexos-3-ulose, d-xylo-hexos-4-ulose, D-xylo-hexos-5-ulose, and D-glucohexodialdose, but only a few fragmentation products. This involves two separate modes of attack: the direct mode (hydrotrioxide-mediated) and the indirect mode (OH(-)-catalyzed, OH-radical-mediated). In its direct attack, ozone preferentially oxidizes C1, with D-gluconic acid being the most prominent product. In the indirect mode, catalyzed by OH(-), hydroxyl radicals are generated that abstract carbon-bound hydrogen almost at random. The glucose radicals so created are transformed by oxygen present in the solution in peroxyl radicals, most of which are able to eliminate superoxide radicals, which in turn react with ozone yielding hydroxyl radicals. That is, a chain reaction ensues. The direct mode predominates at high D-glucose concentrations and in the presence of an OH-radical scavenger (t-butanol), which blocks the chain reaction. The indirect mode gains in importance at low D-glucose concentrations, especially at higher pH, e.g., pH 9. To discriminate between the two modes, gamma-radiolysis (the method of choice for producing OH-radicals in aqueous solution) was employed. It was established that, at neutral pH and a D-glucose concentration of 4 x 10(-3) mol/l, the OH-radical pathway predominates and only 10% of the D-glucose turnover is by the direct mode. (Author's abstract)
W90-03973

OPTIMAL OPERATION OF WATER DISTRIBUTION SYSTEMS.
Texel Electronics, Tel-Aviv (Israel). Dept. of Real-Time Control for Water Systems.
U. Zessler, and U. Shamir.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 735-752, November 1989. 8 fig, 6 tab, 23 ref.

Descriptors: *Water distribution, *Optimization, Programming, Algorithms, Prediction, Hydraulic models, Computers, Mathematical models.

Optimal operation of a water supply system is solved by progressive optimality (PO), an iterative dynamic programming (DP) method. Given the forecasted demands for the coming 24 hr, the initial and final conditions in the reservoirs, the hydraulic properties of all the system components, and the variable energy cost over the day, an optimal schedule of pump operation is found. The algorithm cycles iteratively over the time steps (hours of the day) and network subsystems, and converges to the optimum from any (feasible or infeasible) initial solution. The global optimum is guaranteed only under certain conditions; otherwise a local optimum may be reached. The method was developed and demonstrated on a regional water supply system with eight reservoirs and seven pumping stations. The method has been programmed in Pascal for an IBM PC/XT. A full run for a 24-hr operation takes 10-15 minutes. Therefore, the problem can be rerun at any time during the day if the observed conditions change (e.g., a pump fails or demand changes). The program was written modularly so that it can be applied to water supply systems in which the subsystems appear in any configuration. (Rochester-PTT)
W90-03976

WATER AND URBAN LAND-USE PLANNING IN CALI, COLOMBIA.
Hawaii Univ. at Manoa, Honolulu. Dept. of Geography.
For primary bibliographic entry see Field 6D.
W90-03977

DESIGN OF DILUTION JUNCTIONS FOR WATER QUALITY CONTROL.
Technion - Israel Inst. of Tech., Haifa. Dept. of Mechanical Engineering.
D. Pessen, G. Sinai, K. H. Fasol, and M. Reike.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 829-845, November 1989. 10 fig, 15 ref.

Descriptors: *Water distribution, *Dilution junctions, *Process control, Mixing, Mathematical equations, Optimization, Computer programs, Analog computers, Hydraulic engineering.

Mixing or dilution junctions can extend the available water supply in a region by diluting low-quality (e.g., brackish) water with higher-quality water to yield a mixture suitable for irrigation, industrial, or domestic use. To achieve the best results, the process should be controlled automatically. Typically the controlled variables are salinity, outlet flow, water level, and outlet pressure. The three most promising mixing-junction control configurations are: (1) use of a mixing valve which is activated by a salinity-sensitive controller; (2) use of a mixing valve activated by an on-off level controller; and (3) use of a control valve in each inlet line, one adjusted by a salinity controller and the second by a flow, level, or pressure controller. Steady-state equations were derived, and a microcomputer program developed to simulate steady-state operation. This program helps to determine various design constants of a junction. For a dynamic study, a hybrid computer simulation can be made, with the dynamics of instrumentation simulated on an analog computer. A conclusion of this simulation is that equal-percentage rather than linear-control valves should be used. A cost analysis showed that the lowest cost is achieved using a self-actuated pressure or flow regulator, and a single-speed floating control for salinity. (Rochester-PTT)
W90-03982

CORROSION IN POTABLE WATER SYSTEMS: THE JOHANNESBURG EXPERIENCE.
Johannesburg City Health Dept. Labs. (South Africa).
D. W. Osborn.
Water SA WASADV, Vol. 15, No. 4, p 201-208, October 1989. 5 fig, 2 tab, 25 ref.

Descriptors: *Potable water, *South Africa, *Water distribution, *Corrosion, *Pipelines, Sulfates, Chlorides, Johannesburg, Bacteria, Cost analysis, Maintenance, Cements, Leakage.

The corrosion effects of polyelectrolyte-flocculated water containing sulfate and chloride, and the role of Desulfovibrio desulfuricans in promoting pipe wall penetration in the aging Johannesburg (South Africa) potable water distribution system, are described. Costs and criteria for upgrading the system with cement mortar or high density polyethylene (HDPE) liners and plastic piping are given. A pilot leak detection survey demonstrated the need for continuing field investigations. The Johannesburg situation is noteworthy because of the large numbers of burst mains that were experienced in a very short period of time in many different parts of the city. The age of the pipes was undoubtedly a major contributing factor, but the quality of water in the pipe also appears to have played a major role. The high concentration of sulfates, and occasionally, the high levels of organic matter apparently originating from recycled purified sewage effluents, have provided suitable conditions for the growth of D desulfuricans. The presence of relatively high concentrations of chloride and sulfate ions in the absence of a suitable level of alkalinity, also have contributed to creating corrosive conditions for steel pipes. It cost 77.6 million Rand from 1 July 1982 to 30 June 1987 to replace the water distribution system in Johannesburg. Out of a total of 3000 km of mains (50-1020 mm), 135 km are cement mortar-lined steel pipes, 100 km uPVC, 75 km of HDPE, 132 km slip-lined with 90/140 mm HDPE, 400 km asbestos cement pipes, and the remainder mild steel. (Rochester-PTT)
W90-03988

BOILED AND UNBOILED TAP WATER INTAKE OF CAPE TOWN RESIDENTS.
Cape Town Univ. (South Africa). Dept. of Community Health.
L. T. Bourne, D. E. Bourne, and W. H. J. Hattingh.
Water SA WASADV, Vol. 15, No. 4, p 227-230, October 1989. 5 tab, 14 ref.

Descriptors: *Domestic water, *South Africa, *Public health, *Surveys, Potable water, Cape Town, Tea, Coffee, Diets.

Two surveys of all food and drink items consumed, using a 24-hr recall method, were conducted in summer and winter of 1983 and 1984 in Cape Town. Water consumed was classified as from domestic tap water, commercial beverages, or naturally bound to food. The water also was classified as to whether it had been boiled or not and whether it was consumed at or away from home. Tea and coffee consumption was recorded. Boiled tap water consumption in foods and drinks constituted 64.2%. Boiled tap water derived from tea or coffee amounted to 83.7%. Mean total intake of all forms of water consumed was 1.77 l/head per day. (Author's abstract)
W90-03991

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: III. POLY(ACRYLIC ACID) AND SUBSTITUTED POLY(ACRYLIC ACID) HOMO, CO, AND TERPOLYMER MEMBRANES.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
For primary bibliographic entry see Field 3A.
W90-03993

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: IV. MALEIC ANHYDRIDE COPOLYMERS.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
For primary bibliographic entry see Field 3A.
W90-03994

COMPARATIVE EXAMINATIONS OF THE ADSORPTIVE ELIMINATION AND IDENTIFICATION OF ORGANIC SUBSTANCES IN THE WATER USING DIFFERENT FILTERING MEDIA: PART 2 (VERGLEICHENDE UNTERSUCHUNGEN ZUR ADSORPTIVEN ELIMINIERUNG UND IDENTIFIZIERUNG VON ORGANISCHEN WASSERINHALTSSTOFFEN AN UNTERSCHIEDLICHEN FILTER-MEDIEN). (2. MITT).
For primary bibliographic entry see Field 7B.
W90-03998

IDENTIFICATION OF MUTAGENS IN DRINKING WATER.
Water Research Centre, Medmenham (England). Medmenham Lab.
For primary bibliographic entry see Field 5A.
W90-04007

INFLUENCE OF MATERIALS ON THE MICROBIOLOGICAL COLONIZATION OF DRINKING WATER.
Bonn Univ. (Germany, F.R.). Hygiene Inst.
For primary bibliographic entry see Field 5B.
W90-04008

HAND PUMP CORROSION IN DEEP BOREHOLES--A CASE STUDY ON IMPLEMENTATION OF GROUNDWATER SUPPLIES IN A DEVELOPING COUNTRY.
Interconsult A/S, Sandvika (Norway).
For primary bibliographic entry see Field 5B.
W90-04009

POWDERED OR GRANULAR ACTIVATED CARBON FOR MICROPOLLUTANT REMOVAL.
Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
L. Huber, G. Zimmer, and H. Sontheimer.
Aqua AQUAAA, Vol. 38, No. 2, p 118-130, April 1989. 13 fig, 3 tab, 23 ref.

Descriptors: *Activated carbon, *Filtration, *Adsorbents, *Chlorinated hydrocarbons, *Water treatment, Drinking water, Pesticides, Fouling, Comparison studies, Particle size, Estimating, Data interpretation.

The performance of powdered activated carbon (PAC) and granular activated carbon (GAC) for drinking water treatment processes are discussed with respect to the removal of volatile chlorinated hydrocarbons (VOCs) and pesticides. Considering the effect of 'carbon fouling', a determination parameter based on the carbon use rates was estimated from the comparison of both processes. The results show a higher efficiency for treatment plants using PACs for low influent concentrations and strongly adsorbing compounds. With particular reference to the removal of some pesticides, GAC filters reach only less than 1% of the capacity of the virgin carbon. At high influent concentrations of VOCs, the application of GAC filters is the preferable adsorption process. The proposed calculation method, combined with cost evaluations, gives the criteria for the favorable process design. (Author's abstract)
W90-04010

EFFECT OF ORGANIC CARBON SUPPLY IN WATER ON THE ANTIBIOTIC RESISTANCE OF BACTERIA.
Freshwater Biological Association, Ambleside (England).
J. B. Jones, and R. W. Pickup.
Aqua AQUAAA, Vol. 38, No. 2, p 131-135, April 1989. 1 fig, 1 tab, 20 ref.

Descriptors: *Aquatic bacteria, *Organic carbon, *Culture media, *Bacterial physiology, *Antibiotics, Culturing techniques, Lakes, Bioassay, Limiting nutrients, Natural waters.

Freshwater bacteria were isolated by continuous culture in which the 'medium' was membrane-filtered lake water. Several isolates were grown on media that contained low and high concentrations of organic carbon sources. Those grown at low concentrations of organic carbon were much more resistant to several antibiotics. Lower organic carbon concentrations also resulted in physiological changes in these aquatic bacteria, particularly in the composition of their outer membrane proteins. Such changes have, in other studies on clinical isolates, been associated with nutrient limitation and increased antibiotic resistance, and could be of importance in water storage and supply. Given that this form of resistance is not only confined to antibiotics but may also apply to a range of antibacterial substances such as phenols and chlorine, the results presented here may be of some relevance in the calculation of dosage for all water systems. (Author's abstract)
W90-04011

IMMUNOLOGICAL METHOD USING MONOCLONAL ANTIBODIES TO DETECT ENTEROBACTERIACEAE IN DRINKING WATER.
Stadtwerke Mainz A.G. (Germany, F.R.). Dept. of Water Supplies.
For primary bibliographic entry see Field 5A.
W90-04012

DYNAMIC PARTICLE ADHESION PROCESS AND ITS EFFECT ON PARTICLE AGGREGATION.
Rheinisch-Westfaelische Wasserwerksgesellschaft m.b.H., Muelheim an der Ruhr (Germany, F.R.). Inst. fuer Wasserchemie und Wassertechnologie.
For primary bibliographic entry see Field 2K.
W90-04013

EFFECT OF BROMIDE IONS ON TRIHALOMETHANE (THM) FORMATION IN WATER.
Institute of Public Health, Tokyo (Japan). Dept. of Sanitary Engineering.
T. Aizawa, Y. Magara, and M. Musashi.
Aqua AQUAAA, Vol. 38, No. 3, p 165-175, April 1989. 12 fig, 1 tab, 16 ref.

Descriptors: *Water treatment, *Catalysis, *Bromides, *Trihalomethanes, *Water pollution sources, *Path of pollutants, *Chemical reactions, *Chlorination, Humic acids, Anions, Chloroform, Mathematical equations, Experimental data.

A study was conducted to examine the effect of bromide ions on THM formation. Humic acid solution, which was selected as a model precursor, was chlorinated under various conditions, with variable pH and with or without bromide ions. The amount of chloroform decreased by a proportion of about 0.8 power of bromide ion concentration. However, the amount of brominated THM increased in a proportion of about 0.9 power of the bromide ion content in the sample. The mechanisms of brominated THM formation from ion-containing water were also revealed in laboratory experiments. The amount of THM formed by chlorination of water containing bromide ions could be predicted as the sum of formed chloroform and brominated THM. Experimental equations which gave the THM amount formed were derived by developing equations for predicting chloroform and brominated THM separately through, a series of experiments. The experimental equations were verified by measuring THM formed in chlorinated natural water. (Author's abstract)
W90-04014

MODERN METHODS IN WATER ANALYSIS.
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
For primary bibliographic entry see Field 5A.
W90-04016

APPROPRIATE TECHNOLOGIES–EXAMPLE OF A LARGE BIOLOGICAL IRON REMOVAL PLANT IN TOGO.
Directeur General de la Regie Nationale des Eaux du TOGO, B. P. 1301, Lome, Togo.
Y. Badjo, and P. Mouchet.
Aqua AQUAAA, Vol. 38, No. 3, p 197-206, April 1989. 8 fig, 3 tab, 19 ref. English abstract.

Descriptors: *Water treatment, *Iron bacteria, *Biological treatment, *Water treatment facilities, *Togo, *Municipal water, Technology, Iron, Manganese, Drinking water.

At the end of 1987, a biological iron removal plant was started up for the supply of drinking water to the capital of Togo, Lome. This event marked the introduction of modern biological treatment technologies applied to groundwater in Africa. This article first reviews the principles of dissolved iron and manganese removal by biological means; it then explains the problem Lome had to face for its water supply in view of its increasing needs. In the past, water had been distributed without undergoing a specific treatment, but the nature of new water resources required construction of an iron removal plant. In this typical example, the advantages of the biological process over conventional physico-chemical treatment were evidenced right at the design stage. The first phase (1620 cu m/hr), built in less than one year, was operational from the first day onwards due to the fast natural seeding by iron bacteria of the Gallionella ferruginea species, and has been running to the owner's satisfaction since then. (Author's abstract)
W90-04017

EXPERIENCES WITH GROUNDWATER TREATMENT AND DISPOSAL OF THE ELIMINATED SUBSTANCES IN THE NETHERLANDS.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
J. C. Kruithof, and H. M. M. Koppers.
Aqua AQUAAA, Vol. 38, No. 3, p 207-216, April 1989. 11 fig, 5 tab, 15 ref.

Descriptors: *Water treatment, *Solid waste disposal, *Wastewater disposal, *Sludge utilization, *The Netherlands, *Groundwater, Backwash, Sludge disposal.

In the Netherlands, conventional groundwater treatment is composed of aeration and several types of rapid sand filtration to remove natural constituents such as iron, manganese, ammonia and methane. Additionally, softening has been introduced in many treatment plants. Since the late 1970s groundwater quality has deteriorated sharply through environmental pollution. The major contaminants are nitrates, halogenated solvents and recently, several P pesticides. For that reason, more sophisticated treatment processes such as denitrification, air stripping and granular activated carbon filtration have been added to the conventional treatment system. Groundwater treatment gives rise to a significant production of disposals. The volume of rapid sand filter backwash water amounts to 1-3% of the total drinking water production, representing 10,000 tons of dry solids a year. In most cases lagooning is applied to remove the suspended solids from the backwash water. Many water treatment plants are currently facing serious problems in the disposal of their dry solids, due to the arsenic content of the sludge. Pellet softening treatment plants produce about 17,000 tons of calcium carbonate grains a year. The pellets are disposed of in the cattle feed and lime processing industry. Denitrification, airstripping and granular activated carbon filtration do not leave a significant waste stream on site. (Author's abstract)
W90-04018

POWDERED ACTIVATED CARBON SELECTION FOR WATER TREATMENT.
UMA Engineering Ltd., Mississauga (Ontario).
S. Troxler, D. W. Smith, and E. Knettig.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 743-752, October 1989. 6 fig, 9 tab, 7 ref.

Descriptors: *Organoleptic properties, *Color removal, *Odor control, *Activated carbon, *Filtration, *Adsorbents, *Laboratory methods, *Water treatment, Drinking water, Municipal water.

Increasing concern with color, taste, and odor in municipal water supplies has led to the use of a variety of coagulants, oxidants, and adsorbents for improving water quality. Powdered activated carbon (PAC) is good adsorbent of many organic materials in water. This paper presents a protocol for evaluating various PACs, taking into account the objective of the unit process. The selection protocol is divided into three related lines of action, based on the initial treatment objective choice: a wide variety of compounds; low molecular weight compounds; or high molecular weight compounds. The PAC samples are tested for their absorption capacity for four surrogate compounds: iodine number, for absorption of low molecular weight compounds; phenol, as a substitute for polar, ionic and low molecular weight organic compounds; mesitylene, to determine odor threshold; and tannic acid, as an indicator of a PAC to absorb aquatic humic substances and of color-imparting organic compounds. Using a series of decision criteria, more weight can be placed on the test parameters which relate to the cause of the quality problem. An accurate determination of the capabilities can only be achieved by monitoring trial runs at the water treatment plant. (VerNooy-PTT)
W90-04023

COMPARISON OF OZONE INACTIVATION, IN FLOWING WATER, OF HEPATITIS A VIRUS, POLIOVIRUS 1, AND INDICATOR ORGANISMS.
Tuebingen Univ. (Germany, F.R.). Hygiene Inst.
K. Herbold, B. Flehmig, and K. Botzenhart.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2949-2953, November 1989. 3 fig, 7 tab, 18 ref.

Descriptors: *Water treatment, *Ozone, *Ozonation, *Drinking water, *Viruses, *Aquatic bacteria, Escherichia coli, Bacillus, Disinfection, Bioindicators, Resistance, Human pathogens.

Ozone inactivation of hepatitis A virus (HAV) and poliovirus 1 (PV1) was compared under conditions of constant flow, a situation that corresponding to conditions in a water treatment plant. In steadily flowing water at 20 C and pH 7, five organisms had the following order of resistance to ozone (at constant levels of ozone, 0.03 to .38 mg/L): < Escherichia coli < < Legionella pneumophila serogroup 6 < Bacillus subtilis spores. The tests were repeated at 10 C with HAV, PV1, and E. coli. Ozone inactivation of HAV and E. coli was faster at 10 C than at 20 C. At 20 C, 0.25 to 0.38 mg of O3 per liter was required for complete inactivation of HAV but only 0.13 mg of O3 per liter was required for complete inactivation of PV1. (Geiger-PTT)
W90-04035

FRACTAL GEOMETRY OF PARTICLE AGGREGATES GENERATED IN WATER AND WASTEWATER TREATMENT PROCESSES.
Toronto Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-04049

QUALITY OF COMMUNITY DRINKING WATER AND THE OCCURRENCE OF SPONTANEOUS ABORTION.
Harvard School of Public Health, Boston, MA. Dept. of Epidemiology.
For primary bibliographic entry see Field 5C.
W90-04071

CONCENTRATION OF GIARDIA LAMBLIA CYSTS, LEGIONELLA PNEUMOPHILA, CLOSTRIDIUM PERFRINGENS, HUMAN ENTERIC VIRUSES, AND COLIPHAGES FROM LARGE VOLUMES OF DRINKING WATER, USING A SINGLE FILTRATION.
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
P. Payment, A. Berube, D. Perreault, R. Armon, and M. Trudel.
Canadian Journal of Microbiology CJMIAZ, Vol. 35, No. 10, p 932-935, October 1989. 1 fig, 1 tab, 27 ref.

Descriptors: *Filtration, *Drinking water, *Enteroviruses, *Bacteriophage, *Giardia, *Clostridium, *Legionella, *Water analysis, *Viruses, Public health, Microorganisms.

Poliovirus, coliphages, Giardia lamblia cysts, Clostridium perfringes spores, and Legionella pneumophila were concentrated simultaneously in a single pass by sequential filtration of large volumes of drinking water through 3 and 1 micrometer wound electronegative fiberglass cartridge filters (25.4 cm). Filtration was performed under acidic conditions (pH 3.5) in the presence of 0.002 M aluminum chloride to enhance adsorption. Elution of all the microorganisms entrapped or adsorbed to the filters was obtained by a slow backwash elution with a 1.5% beef extract solution, pH 9.75, containing 0.5% Tween 80. Tween 80 was shown to enhance recovery of the bacteriophages, bacteria, and parasites. Giardia cysts were efficiently eluted (71%) and could be reconcentrated by low-speed centrifugation and purified by sucrose density gradient flotation at a final recovery of 52%. Legionella pneumophila cells were eluted at 64% and were further concentrated by low-speed centrifugation at an overall recovery of 55%. C. perfringens spores and coliphages were eluted at efficiencies of 82 and 86%, respectively, and reconcentrated with minimal loss by a detergent-protein flotation method. Poliovirus was eluted at 93% and reconcentrated at 78% efficiency by organic flocculation. (Author's abstract)
W90-04095

GEOGRAPHIC ANALYSIS OF THE INCIDENCE OF CANCER IN QUEBEC AS A FUNCTION OF THE UTILIZATION OF PESTICIDES IN AGRICULTURE, 1982-1983 (ANALYSE GEOGRAPHIQUE DE L'INCIDENCE DES CANCERS AU QUEBEC EN FONCTION DE L'UTILISATION DES PESTICIDES EN AGRICULTURE, 1982-1983).
Montreal Univ. (Quebec). Dept. of Geography.
For primary bibliographic entry see Field 5C.
W90-04096

WATER SUPPLY AND SANITATION: AN AGENDA FOR RESEARCH.
London School of Hygiene and Tropical Medicine

(England).
S. Cairncross.
Journal of Tropical Medicine and Hygiene JTMHA9, Vol. 92, No. 5, p 301-314, October 1989. 1 tab, 64 ref.

Descriptors: *Public health, *Drinking water, *Political aspects, *Sanitation, International Drinking Water Supply and Sanitation Decade, Health Research for Development, Tropical regions, Wastewater treatment, Sewer systems, Water supply, Urban areas, Groundwater pollution, Developing countries.

As the International Drinking Water Supply and Sanitation Decade (1981-1990) draws to a close, and the international community discusses plans to follow it with a second decade focussed on these and other issues of environmental health, the formation of the commission on Health Research for Development provides a useful opportunity to review progress in this area over the last 10 years. With regard to water supply, the problems were largely regarded as technical or economic, with little reference to social or institutional aspects. Sanitation was largely neglected. Urban sanitation was usually understood to mean sewerage, so that the low-income majority of the population of most tropical cities, for whom sewerage is neither feasible nor affordable, were automatically excluded. Much of the last 10 years' research has focussed on technical issues such as hand-pump design and sanitation technology. The next decade will see the development of cheaper techniques for locating and drilling boreholes, and of a lightweight motor-pump suitable for dewatering wells when the digging teams have reached a depth greater than 8 m. In the sanitation sector, we can hope for a clearer understanding of sludge accumulation rates and of factors affecting the capacity of tropical soils to absorb liquid wastes. Technical research has focussed on hand-pump design, water filtration, water microbiology, wastewater treatment, ground water pollution and pit latrine emptying equipment. The health impact of water supply and sanitation has been considered as something of a taboo subject by the World Bank and the World Health Organization. Recently, however, both bodies have renewed their interest in the subject. This has facilitated the development of fresh approaches to the methodology of health impact measurement (Mertz-PTT)
W90-04110

DIATOMACEOUS-EARTH WATER FILTRATION.
O'Brien and Gere Engineers, Inc., Syracuse, NY.
D. G. VanArnam, and M. J. Dent.
Water Engineering and Management WENMD2, Vol. 136, No. 10, p 35-36, October 1989.

Descriptors: *Water treatment facilities, *Potable water, *Filtration, *Diatomaceous earth, Costs, New York, Giardia, Turbidity, Drinking water.

When the village of Clayton, New York, installed a diatomaceous-earth filtration system to treat its water supply, it realized an estimated 30% cost savings over conventional rapid sand and dual-media filtration. Though the village had not experienced problems with the intestinal parasite, Giardia lamblia, the installation and proper use of a diatomite filtration system has been found in tests and practice to prevent Giardia cysts from entering water supply systems. With the diatomite-filtration system, Clayton obtained a finished water quality of 0.5 nephelometric turbidity units, well under the New York State Department of Health required standard of 1.0. Water production is greater than with other water-filtration systems because only 0.1 to 0.2% throughput, as opposed to 2 to 5%, is used in backwashing. The small area required to set up a diatomite-filtration system contributed to the lower capital cost and facilitated operation of the water treatment plant. The Clayton, NY water treatment system has been running smoothly since 1983. (Mertz-PTT)
W90-04116

OHIO PERMITS PRESSURE CLARIFICATION/FILTRATION.
Green Cove, Ohio.
R. J. Young.
Water Engineering and Management WENMD2, Vol. 136, No. 10, p 39-40, Oct 1989.

Descriptors: *Water treatment facilities, *Filtration, *Clarifiers, Ohio, Lake Erie, Color removal, Organoleptic properties.

In 1988, a pressure clarification/filtration system was installed to serve Green Cove, a 750-unit condominium complex on the shores of Lake Erie in Ohio. The system in use at Green Cove is a duplex system. It has two trains each having a pressure clarifier, a multimedia depth filter, and a carbon filter. All tanks are 72 inches in diameter; the sideshell heights of the clarifier and depth filter are 60 inches and the height of the carbon unit is 84 inches. A chemical-feed system feeds alum to the system to aid in filtering, and to increase adsorption of color and taste by the filter media. A flocculant-feed system is available but seldom used. The clearwells have a total capacity of 220,000 gal. and each alone provides enough water for a normal day's use by residents during peak summer periods. The water-treatment system has a capacity of 320,000 gal./day, so it is not necessary to run the system constantly, another cost savings. Water pressure to the system is provided by two conventional submersible well pumps. Filters are backwashed manually by the operator after each service run to satisfy Ohio EPA monitoring requirements, but backwashing can also be done automatically. (Mertz-PTT)
W90-04117

AQUEOUS OZONATION OF A QUATERNARY AMMONIUM SURFACTANT.
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
C. Corless, G. Reynolds, N. Graham, R. Perry, and T. M. Gibson.
Water Research WATRAG, Vol. 23, No. 11, p 1367-1371, November 1989. 5 fig, 1 tab, 15 ref.

Descriptors: *Surfactants, *Water treatment, *Ozonation, *Oxidation, Pollutants, Gas chromatography, Quaternary ammonium compounds, Mass spectrometry.

The reactivity of a mixture of saturated and unsaturated quaternary ammonium surfactants (QAS) towards ozone was examined at a total substrate concentration of 500 microgram/L. Saturated components were unreactive; unsaturated components of the surfactant were reactive towards ozone. A number of reaction products or their methylated derivatives were identified by gas chromatography, gas chromatography-mass spectrometry and fast atom bombardment-mass spectrometry. The conditions under which the experiment was carried out and the nature of the reaction products identified strongly suggest that 1,3-dipolar cycloaddition of ozone across the carbon-carbon double bond of the unsaturated QAS components was the major mechanism by which reaction occurred. The results show that compounds which may be found in raw water can be converted to different classes of compounds under typical water treatment conditions. (Author's abstract)
W90-04143

EVALUATION OF WATER QUALITY AS MEASURED BY BACTERIAL MAXIMUM GROWTH RATE.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
O. Adam, and Y. Kott.
Water Research WATRAG, Vol. 23, No. 11, p 1407-1412, November 1989. 2 fig, 5 tab, 21 ref. Israel NCRD and German KFK Research grant WT243.

Descriptors: *Water treatment, Water quality, Bacterial analysis, *Ozonation, Measuring instruments, Growth rates, Growth media.

The ability of bacteria to utilize micropollutants in water at the various stages of treatment and in the distribution system was investigated by using sensitive turbidimeters measuring turbidity at 12 degrees forward scattering light, attached to a Hewlett-Packard minicomputer. The maximum growth rate (MGR) of the bacteria in the water examined was calculated. The results showed that raw water entering the treatment plant had a high MGR; after ozonation much lower MGR values were observed. Well water that was mixed with the treated water again showed a high MGR, but the final water had a relatively low MGR. When the same water was inoculated and incubated, the MGR was measured. The bacteria were removed and the water was inoculated again, incubated, and MGR was measured. This procedure was repeated five times. After the fifth time no growth could be measured, which indicated a depletion of the growth materials. The MGR measurements seem to be a promising method fo evaluating the efficiency of the treatment stages, and for estimating regrowth possibility in the distribution system. (Author's abstract)
W90-04148

EXPERIMENTAL TESTING OF MATHEMATICAL MODELS DESCRIBING THE ENTIRE CYCLE OF FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran, and J. S. Chang.
Water Research WATRAG, Vol. 23, No. 11, p 1413-1421, November 1989. 9 fig, 2 tab, 7 ref.

Descriptors: *Model studies, *Water treatment, *Filtration, *Mathematical models.

Two mathematical models developed based on different concepts to describe the entire cycle of filtration were tested with experimental results. The concept of Model I is based on the detachment of deposited particles. The degree of detachment was assumed proportional to the hydraulic gradient and number of particles already retained on the filter grain. Model II is based on the concept that there exists a maximum limit on particle deposition on the filter grain. It was found that Model I, based on the detachment assumption, can simulate better than Model II. This may be an experimental proof for the concept of detachment which is now agreed by most researchers. The ultimate specific deposit was estimated experimentally for different velocities to give a qualitative justification on the applicability range of the proposed models. (Author's abstract)
W90-04149

ANION EXCHANGE FOR REMOVAL OF HUMUS FROM DRINKING WATER: CALCIUM IMPROVES THE EFFICIENCY OF THE PROCESS.
National Inst. of Public Health, Oslo (Norway).
D. Hongve.
Water Research WATRAG, Vol. 23, No. 11, p 1451-1454, November 1989. 4 fig, 6 ref.

Descriptors: *Drinking water, *Humic substances, *Anion exchange, *Water treatment, *Calcium, *Lime, Resins, Alkalinity, Hydrogen ion concentration.

The reaction rate between dissolved humic substances and a macroporous anion exchange resin is shown to increase with increasing calcium concentration. An anion exchange process for humus removal has been operated in laboratory scale. Calculation of ionic balance shows that all carboxylic groups in the humic substances are active in the binding reaction with the resin. The process removes alkalinity from the water and additional treatment for adjustment of pH and alkalinity is necessary. Dissolution of granular limestone in the water before the ion exchange is a simple remedy that also improves the efficiency and capacity for humus removal. (Author's abstract)
W90-04154

EVALUATION OF CONSUMER NOTIFICATION UNDER THE SAFE DRINKING WATER ACT.
California Univ., San Francisco.
L. A. Wardlaw, and W. H. Bruvold.

Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 837-844, August 1989. 2 tab, 21 ref.

Descriptors: *Safe Drinking Water Act, *Drinking water, *Public health, *Public relations, Public policy, Notification policy, Water quality standards, Impaired water quality.

The Safe Drinking Water Act of 1974 as amended in 1986 requires that consumers be notified when maximum contaminant levels are exceeded in their community water supply and when prescribed testing and treatment procedures are not met. A review of communication theory indicates that for the message to be effective (1) it must be received by the intended audience, (2) it must be attended to by that audience, (3) it must be understood, and (4) it must be accepted and acted upon. A review and analysis of existing research evaluating notification programs administered under the Safe Drinking Water Act indicates (1) that receipt rates have been highly variable, (2) that attention to the message has usually not been directly assessed, (3) that levels of understanding, while variable, have usually been minimal, and (4) that acceptance, though not often directly measured, seemed higher than expected. These results, while critical of past notification programs, indicate that understanding and acceptance can be increased if receipt and attention rates are increased. The following recommendations are suggested: (1) distribute written messages to the population served; (2) consider the appearance of the notice and vary contents for repetitions; (3) describe the problem in simple, understandable language; (4) describe the nature of the contaminant and its effects; (5) describe the solution; and (6) use the notification process as and opportunity to educate consumers about broader issues affecting drinking water. (Author's abstract)
W90-04181

PEAKING STORAGE TANKS FOR WATER SUPPLY SYSTEMS.
Memphis State Univ., TN. Dept. of Civil Engineering.
M. H. Sabet, and O. J. Helweg.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1047-1053, October 1989. 9 fig, 1 tab, 17 ref.

Descriptors: *Water conveyance, *Water storage, *Municipal water, Peaking storage tank, Economic aspects, Model studies, Energy costs, Construction costs.

Construction of a 'peaking storage tank' may reduce the operational cost of municipal water by making available a time-of-use energy rate. A peaking storage tank is used for storing water that is pumped from wells, or other sources of supply, during off-peak periods when energy costs are less, for use during periods of on-peak water demand. The optimal size of a peaking storage tank is that which results in the minimum total cost, which includes both the storage construction cost and the cost of pump operation. The operational cost for a given time-of-use rate is determined with the help of a pipe network simulation model utilizing the Newton-Raphson technique and a dynamic programming optimization model, or the more simplified method developed that involves the use of a pumping rate vs energy use curve. The simplified method should only be used if a network model is unavailable or if a city does not have access to computer facilities. Analyses show that low off-peak energy costs make the construction of peaking storage tanks economically attractive and reduce on-peak energy use, which results in electrical load leveling. (Author's abstract)
W90-04210

WATER SUPPLY AT LOS ALAMOS: CURRENT STATUS OF WELLS AND FUTURE WATER SUPPLY.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 2F.
W90-04259

SOLAR PHOTOCHEMICAL PROCESS FOR DESTROYING ORGANICS IN WATER.
Sandia National Labs., Albuquerque, NM.
J. T. Holmes, and C. A. Haslund.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-000503. Price codes: A03 in paper copy, A01 in microfiche. Report No. SAND-88-1235C, (1989). 12p, 3 fig, 1 tab, 10 ref. DOE Contract DE-AC04-76DP00789.

Descriptors: *Solar radiation, *Water treatment, *Organic compounds, *Photolysis, Oxidation, Evaporation, Catalysis, Reactors, Process control.

Recent scientific literature indicates the potential benefits of using photocatalytic oxidation reactions for the destruction of organic contaminants in water. The processes utilize solid or dissolved photon-activated catalysts to break down low concentrations of hazardous organic chemicals into carbon dioxide and simple acids. Concentrated sunlight was studied in a falling-liquid-film reactor that has the following characteristics: (1) The ability to utilize high solar (photon) flux densities without overheating or evaporating the fluid or contaminants; (2) excellent interaction, in the thin film of fluid, between concentrated sunlight, catalyst and contaminants in the fluid; (3) easy doping with reactants and solid or dissolved catalysts; (4) high capacity; and (5) easy process control. The capability of the falling liquid film photochemical reactor was extended to average incident flux densities of over 85 kW/sq m. About half of the incident power is absorbed by the falling water film. (Lantz-PTT)
W90-04263

CAD IN THE DESIGN OF PIPELINES FOR IRRIGATION SCHEMES.
Lotti (C.) and Associates, Rome (Italy).
For primary bibliographic entry see Field 8A.
W90-04291

REPRO: HYDRAULIC NETWORK DESIGN.
Lotti (C.) and Associates, Rome (Italy).
For primary bibliographic entry see Field 8A.
W90-04292

TOXICS AND THE SAFE DRINKING WATER ACT.
Passaic Valley Water Commission, Clifton, NJ.
For primary bibliographic entry see Field 6E.
W90-04363

REHABILITATION OF WATER SYSTEMS.
Massachusetts Metropolitan District Commission, Boston.
J. O'Brien.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 252-258.

Descriptors: *Conveyance structures, *Water conveyance, *Urban hydrology, *Water pollution control, *Governmental interrelations, *Regulations, *Urban areas, *Maintenance, *Water supply, *Water quality control, Drinking water, Federal jurisdiction, Financing, Taxes.

Whether or not the rehabilitation or replacement of obsolete water treatment and distribution systems be considered a national program is addressed. Using the Boston Metropolitan Area as an example of the water supply systems found in the northeastern Untied States, the following arguments are presented: (1) that the Federal government has moved strongly into the regulation of the quality of drinking water. These regulations place a sudden and largely unanticipated burden on water suppliers. When the Federal government regulates, it may also have an obligation to assist. Such assistance has been considered necessary in a wide range of other Federal regulatory programs; (2) The Federal income tax is levied without regard to geographical distribution--and there should be some equity in terms of accessibility to Federal funding programs. Federal monies available for water projects have been largely unavailable to the northeast; (3) wise use, of limited resources is needed. Increasingly, water issues are problems of allocation raising interstate and even international controversies. These interstate and international roles are uniquely Federal, and as the Federal government works toward compromise and resolution, it will have to examine all those small actions that lead cumulatively to the problem; and (4) policy. New Federal water policy should be more directly supportive of new Federal urban policy. (See also W90-04338)(Lantz-PTT)
W90-04364

MECHANISMS OF METAL ION ADSORPTION ON ACTIVATED ALUMINA.
Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.
J. W. Novak, R. R. Burr, and R. Bednarik.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 475-492, 8 fig, 4 tab, 46 ref.

Descriptors: *Adsorption, *Water treatment, *Metals, *Selenium, *Alumina, *Wastewater treatment, Ions, Metal complexes, Reviews, Calorimetry.

Numerous adsorption models have been proposed to describe metal ion adsorption on hydrated alumina surfaces. The number of models reflects the complexity of the surface and the difficulty in characterizing types of surface-metal interactions. Methods have ;been developed for collecting and interpreting data on metal ion adsorption behavior. Several important variables investigated which influence metal ion and adsorbent interactions include pH, adsorbent and adsorbate types, and solution conditions (e.g., ionic strength). Data was used from calorimetric studies and potentiometric titrations to predict adsorption mechanisms for metal ions. Se(IV) and Se(VI) adsorption on Alcoa 'CPN' activated alumina was studied; selenium adsorption was measured on activated alumina as functions of pH and ionic strength. Results indicate that Se(VI) adsorbs primarily by electrostatic attachment/ion exchange, and Se(IV) adsorption is probably dominated by chemisorption-type interactions such as hydrogen bonding. A variety of metal ions (e.g., Cr(III), Cr(VI, Zn(II)) are being tested as sorbates for evaluating the types of interactions between alumina surfaces and metal ions. (See also W90-04370) (VerNooy-PTT)
W90-04384

ADSORPTION OF INORGANIC ARSENIC AND ORGANOARSENICAL ON HYDROUS OXIDES.
Pennsylvania State Univ., University Park.
M. M. Ghosh.
IN: Metals Speciation, Separation, and Recovery. Lewis Publishers, Chelsea, Michigan. 1987. p 499-518, 13 fig, 3 tab, 25 ref. EPA Grant R 809425010.

Descriptors: *Water treatment, *Adsorption, *Aluminum, *Arsenic, *Contact beds, Hydrogen ion concentration, Chemical reactions, Metal complexes, Arsenicals.

Adsorption of arsenic on activated alumina is greatly affected by pH. High adsorption densities of arsenate and organoarsenicals can be obtained at pH less that the pH of the zero point of charge. Maximum adsorption of arsenate occurs at pH 5 or less. The specific adsorption of arsenate, monomethyl arsenate, and dimethyl arsenic acid can be described well by the Langmuir isotherm, while arsenite adsorption can not. Although no satisfactory fit of data on arsenate adsorption could be obtained to the surface complexation models examined, it appears that, in the pH range 4 to 8, H2ASO4(-) and HASO4(--) are the predominant species that are adsorbed. Both coulombic and specific chemical interactions seem to be involved in the adsorption of arsenate on hydrous alumina. Arsenite adsorption was unsatisfactory. Of the two organoarsenicals studied, monomethylarsenate seems to be better adsorbed on alumina than dimethyl arsenic acid. Experiments with fixed beds of alumina indicated that arsenic can be effectively removed for long periods of time at an empty bed contact time of 3 min or longer and at low mass loading rates in the pH range of 4 to 7. Results also

indicate that removal is best accomplished in the arsenate form. Successful regeneration of spent alumina beds to desorb arsenic is feasible with NaOH at concentrations as low as 0.5%; but a much stronger caustic solution (3%) is needed for arsenite desorption. No appreciable loss in adsorption capacity occurs due to regeneration. The loss of alumina can be held at 3% per regeneration. (See also W90-04370) (VerNooy-PTT)
W90-04385

PLUMBING AND DISTRIBUTION SYSTEMS FOR DRINKING WATER. JANUARY 1970-JANUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855514. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 119 p. Supersedes PB86-861903.

Descriptors: *Bibliographies, *Drinking water,*Water conveyance, *Water distribution, *Plumbing, *Pipes, Literature review, Corrosion control, Asbestos, Leaching, Leakage, Water loss, Municipal water, Bacteria, Heavy metals, Public health, Organoleptic properties, Model studies.

This bibliography contains 244 citations concerning plumbing and water pipes in drinking water distribution systems. Included are references to locating and correcting leaks in municipal piping systems, cleaning of old piping systems, leaching from vinyl-lined pipe, asbestos fibers from piping systems, corrosion control, security of water distribution systems, bacterial contamination and growth within the system, and heavy metal concentrations, especially lead from lead linings or lead solder joints. Some citations cover health studies, odor, and taste, and a few cover management information systems and modeling techniques for water distribution systems. One hundred thirty-five citations are new entries to the previous edition. (See also W90-04480) (Author's abstract)
W90-04478

PLUMBING AND DISTRIBUTION SYSTEMS FOR DRINKING WATER. JANUARY 1977-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855332. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 95 p. Supersedes PB86-861846.

Descriptors: *Bibliographies, *Drinking water,*Water conveyance, *Water distribution, *Plumbing, *Pipes, Literature review, Corrosion control, Asbestos, Leaching, Leakage, Water loss, Municipal water, Bacteria, Heavy metals, Public health, Organoleptic properties, Water conservation.

This bibliography contains 156 citations concerning plumbing and water pipes in drinking water distribution systems. Included are references to leaks in municipal piping systems, cleaning of old piping systems, leaching from vinyl-lined pipe, asbestos fibers from piping systems, corrosion control, and heavy metal concentrations, especially lead from lead linings or lead solder joints. The citations also include health studies, microbial growth, odor, taste, and water conservation devices. Eighty-two citations are new entries to the previous edition. (See also W90-04478) (Author's abstract)
W90-04480

ION EXCHANGE RESINS. JANUARY 1988-DECEMBER 1988 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3A.
W90-04486

ION EXCHANGE RESINS. OCTOBER 1983-DECEMBER 1987 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3A.
W90-04487

ASBESTOS IN DRINKING WATER. JANUARY 1977-MARCH 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5C.
W90-04501

5G. Water Quality Control

BIOTECHNOLOGY FOR DEGRADATION OF TOXIC CHEMICALS IN HAZARDOUS WASTES.
For primary bibliographic entry see Field 5D.
W90-03562

TOXICITY ASSAYS AND MOLECULAR STRUCTURE TOXICITY.
Drexel Univ., Philadelphia, PA.
For primary bibliographic entry see Field 5C.
W90-03565

PHYSICAL-CHEMICAL AND ANAEROBIC FIXED FILM TREATMENT OF LANDFILL LEACHATE.
Technical Univ. of Nova Scotia, Halifax. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03571

TREATMENT OF LEACHATE FROM A HAZARDOUS WASTE LANDFILL SITE USING A TWO-STAGE ANAEROBIC FILTER.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-03572

EFFECTS OF EXTENDED IDLE PERIODS ON HAZARDOUS WASTE BIOTREATMENT.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-03573

BIOTECHNOLOGY FOR THE TREATMENT OF HAZARDOUS WASTE CONTAMINATED SOILS AND RESIDUES.
Cook Coll., New Brunswick, NJ. Dept. of Biological and Agricultural Engineering.
M. E. Singley, A. J. Higgins, V. S. Rajput, S. Pilapitiya, and R. Mukherjee.
IN: Biotechnology for Degradation of Toxic Chemicals in Hazardous Wastes. Noyes Data Corporation, Park Ridge, New Jersey. 1988. p 359-375, 4 fig, 1 tab, 22 ref.

Descriptors: *Cleanup, *Decontamination, *Biotechnology, *Hazardous wastes, *Soil contamination, *Biological treatment, *Physicochemical treatment, Biodegradation, Calorimetry, Microbial degradation, Soil organisms, Sludge, Toxicity, Benzenes, Microbiological studies, Metabolism, Heat flow.

The research reported in this paper deals with the development and use of biotechnology for treating contaminated soils and waste residues at the site of the problem. The major treatment methods include physical/chemical washing of soils and waste residues as a pretreatment followed by biological degradation. The microcalorimeter is a device that offers a convenient and relatively quick way of determining the interaction of the microbiological community with a contaminant. The microbial activity in terms of heat output for a one gram sample is termed a 'thermogram'. A normalization test performed on a sample that is the organic medium to sustain the microbiological community will reflect the endogenous activity of the microorganisms present. Adding a contaminant to sewage sludge at various rates will determine the input of the toxicant on the microbiological community. If the added compound is a toxicant, the heat output will be less than for the normalized thermogram. If the compound can be metabolized, the heat flux will be greater. The change in heat output may then be considered a measure of the degradation response of the microorganisms. A thermographic analysis on sewage sludge contaminated with 1,2,4-trichlorobenzene indicate that biodegradation can be used to decontaminate soils. However, additional organic toxicants and additional environmental parameters must be explored. (See also W90-03562) (Lantz-PTT)
W90-03580

BIOLOGICAL DEGRADATION OF POLYCHLORINATED BIPHENYLS.
General Electric Corporate Research and Development, Schenectady, NY. Biological Sciences Branch.
For primary bibliographic entry see Field 5E.
W90-03581

PATAPSCO WASTEWATER TREATMENT PLANT TOXICITY REDUCTION EVALUATION.
Engineering Science, Fairfax, VA.
For primary bibliographic entry see Field 5D.
W90-03595

RESPIRATION-BASED EVALUATION OF NITRIFICATION INHIBITION USING ENRICHED NITROSOMONAS CULTURES.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-03597

ASSESSMENT OF THE DEGREE OF TREATMENT REQUIRED FOR TOXIC WASTEWATER EFFLUENTS.
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-03598

MANAGEMENT USE OF SCIENTIFIC INFORMATION.
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
For primary bibliographic entry see Field 6A.
W90-03624

SCIENTIFIC, TECHNICAL AND REGULATORY CONSIDERATIONS IN ENVIRONMENTAL MANAGEMENT.
Alaska State Dept. of Environmental Conservation, Juneau. Water Quality Management Section.
D. R. Redburn.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 375-402, 1 fig, 1 tab, 17 ref.

Descriptors: *Regulations, *Water pollution prevention, *Valdez, *Alaska, *Permits, Water quality management, Environmental policy, Environmental protection, Wastewater disposal, Aromatic compounds, Alaska pipeline, Monitoring.

The regulatory process followed in the permitting and negotiation of the receiving water monitoring program for the Alyeska Pipeline Service Company ballast water treatment plant from 1974 through August 1986 reviewed. Early marine studies in Port Valdez during 19711-72 and studies conducted under stipulation in the initial 1975 National

Pollutant Discharge Elimination System (NPDES) permit provided a framework to guide the post-discharge monitoring program of 1980 to the present. Study emphasis evolved from strictly traditional population and community studies to also include a focus on subtle, sublethal indices of environmental health. The close relationship between the scientific information obtained over the last decade and governmental regulation of this industrial facility is evident in three notable areas. First, revisions to Alaska water quality standards in 1979 to include a total aromatic hydrocarbon criterion was in clear response to mounting scientific evidence pointing to the toxicity of water soluble aromatic fractions of the petroleum hydrocarbon spectrum. This standard was made an integral part of the 1980 NPDES permit effluent limitations and receiving water monitoring program. Second, the gradual refinement and greater sophistication of receiving water monitoring studies conducted from 1974 to the present was based on substantive discussion with the involved academic community and through written and verbal statements of impact hypotheses which served to guide development of a more cost-effective monitoring program. Third, the results of the receiving water and effluent monitoring programs have led to selective enforcement action to modify plant operational and reporting procedures and reduce upsets in discharge levels. (See also W90-03610) (Lantz-PTT)
W90-03625

PROCEEDINGS, MISSISSIPPI WATER RESOURCES CONFERENCE.
Mississippi Water Resources Research Inst., Mississippi State.
For primary bibliographic entry see Field 5F.
W90-03708

GROUNDWATER SENSITIVITY MODELING USING GIS TECHNOLOGY.
Mississippi Research and Development Center, Jackson.
P. A. Curtis.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 9-16. 5 fig.

Descriptors: *Sensitivity analysis, *Water pollution sources, *Geographic information systems, *Model studies, *Groundwater pollution, *Potable water, *Water pollution control, *Groundwater quality, Wells, Underground storage, Leaching, Landfills, Information systems, Data collections, Subsurface mapping, Deep wells.

The Bureau of Pollution Control of the Mississippi Dept. of Natural Resources (DNR) contracted with the Mississippi Automated Resource Information System (MARIS) Technical Center to provide technical services using the MARIS geographic system (GIS) to model groundwater sensitivity by determining potential contamination sites within one mile of public water supply wells. This model would help identify potentially vulnerable water wells and help the Bureau of Pollution Control establish priority areas for future water quality investigations. A total of 497 water wells from the USGS database were considered in the project. Criteria were that the wells be for public water supply and be less than 351 feet deep. The potential contamination (PC) sites identified were underground storage tank facilities, surface impoundment sites, permitted landfills, open dumps, and business and industries registered with the EPA as regulated facilities. Latitude and longitude coordinates were digitized from marked maps; when all components for the model were thus referenced, GIS analytical capabilities could begin. The output products of the project consist of maps and reports that depicted the wells and their PC sites and additional information on PC sites, including: attribute report of all wells under investigation, composite report of radial search findings, attribute report of private wells within one mile of a PC site, 94 paper plots of wells, PC sites, and search areas, and one paper and one mylar statewide plot of all shallow public water supply wells and PC sites except underground storage tanks. In the future, the project can be expanded by addressing deep public supply wells and private water wells. (See also W90-03708) (Friedmann-PTT)
W90-03711

SUMMARY OF THE 1986 AMENDMENTS TO THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 6E.
W90-03713

WATER QUALITY MANAGEMENT FOR PH CONTROL.
Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
P. N. Deliman, J. W. Pote, and T. P. Cathcart.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 47-52. 2 tab, 17 ref. USGS grant PL 98-242.

Descriptors: *Water quality management, *Wastewater treatment, *Water treatment, *Water quality control, *Hydrogen ion concentration, *Aquaculture, *Hardness, Eutrophication, Calcium, Sulfates, Water chemistry, Alkalinity, Carbon, Acetic acid, Calcium carbonate, Statistical analysis, Calcium sulfate, Calcium chloride.

In intensive aquaculture, high-density algal blooms can cause marked fluctuations in pH. Three different sources of calcium and two sources of carbon were tested to determine their effectiveness in controlling pH. The sources of calcium included calcium sulfate, calcium chloride, and calcium carbonate, with levels added to exceed that needed to equal the total alkalinity as CaCO3 by 50% to 2,000%. Carbon sources were 500 ml of glacial acetic acid and three levels of organic carbon (425, 850, and 1700 g) added to ground corn. All of the calcium sources were successful in increasing the total hardness levels, except for calcium carbonate. The calcium sources that were successful in increasing the total hardness levels were also successful in maintaining the increased hardness levels for the duration of the experiment in which they were being tested. The glacial acetic acid treatments proved to be insignificant during the 1st, 2nd, 3rd, and 4th week of treatment, over the entire experiment. When the calcium carbonate treatments were tested for significance during the 1st, 2nd, 3rd, and 4th week, and the overall effect of the treatments, only treatment 1 (the 100% level) had a significant treatment effect at the alpha=0.05 level during the 4th week. The combined treatment effect of the calcium carbonate treatments were significant only during the 4th week at the alpha = 0.05 level. When testing the ground corn treatments for significance during the 1st, 2nd, 3rd and 4th week, and overall effect of the treatments, it was found that all of the ground corn treatments were significant at alpha < 0.01 in all but the 1st week of data. Since the calcium sources were not significant factors in controlling high pH, they should be abandoned and other methods of accomplishing this task should be examined. (See also W90-03708) (Friedmann-PTT)
W90-03717

SYSTEMS APPROACH TO WATER QUALITY MANAGEMENT DURING DROUGHT PERIODS IN THE CUMBERLAND RIVER BASIN.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
D. F. Hayes.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 59-62. 2 fig, 3 ref.

Descriptors: *Systems analysis, *Water quality management, *Cumberland River Basin, *Water management, *Water quality control, *Drought, *Water shortage, *Reservoir operation, *Low flow, Water scarcity, Reservoirs, Computer models, Management planning, Algorithms, Reservoir releases, Streamflow forecasting, Control theory, Multipurpose reservoirs, Stratification, Linear programming.

Operating complex water resource systems like interdependent multi-objective hydropower reservoirs to satisfy competing objectives is difficult. Most reservoirs are operated according to a guide curve that provides monthly headwater targets that meet reservoir and basin objectives under normal conditions. A method is presented to determine alternative operating strategies under stratification and drought conditions. The Cumberland River basin in northern Tennessee and southern Kentucky is used as an example. The annual low-flow season in the Cumberland River basin provides a complicated scenario which is exacerbated by drought conditions. Natural stratification of the reservoirs begins during the summer months and continues into September, coinciding with the low-flow period. A model, for use on a desktop personal computer, is presented for management of the Cumberland River system during these low-flow periods. An initial management strategy will developed from model runs based upon forecast inflows and system state in early summer. The Optimal Control Theory algorithm is used to determine optimum daily releases and is faster and requires less memory space than Successive Linear Programming. The management strategy will recommend headwater elevation and release targets that satisfy the performance index set forth for the system. By initiating management alternatives early in the low-flow season, less drastic measures should be necessary late in the period. (See also W90-03708) (Friedmann-PTT)
W90-03719

SAFE DRINKING WATER ACT: AMENDMENTS, REGULATIONS AND STANDARDS.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 218 p. Edited by Edward J. Calabrese, Charles E. Gilbert, and Harris Pastides.

Descriptors: *Water treatment, *Safe Drinking Water Act, *Regulations, *Standards, *Drinking water, *Water quality control, Public health, Legislation, Radioisotopes, Volatile organic compounds, Inorganic compounds, Organic compounds, Disinfection.

Congress responded to concerns about the quality of drinking water by passing the Safe Drinking Water Act (SDWA) in 1974 and the Safe Drinking Water Act Amendments of 1986. This book approaches the topic of safe drinking water by communicating how the EPA has responded to the mandates of Congress (mainly the SDWA Amendments of 1986). It includes an independent, non-EPA viewpoint, with particular attention to public health concerns associated with drinking water treatment practices, especially disinfection (Chapter 12). Chapter 1 summarizes what is and will be involved in achieving safe drinking water. Chapter 2 describes the historical development of drinking water regulations. Chapter 3 summarizes the directives of the Safe Drinking Water Act Amendments of 1986, describes the philosophy of and some of the methods used by the EPA in developing the drinking water regulations, and defines some of the terms used in the regulations. Chapters 4 through 9 discuss each phase of the regulatory program in turn. Specific problems associated with volatile organic chemicals, synthetic organics, inorganic chemicals, and microbiological contaminants are assessed in Chapter 4 and 5. The unique characteristics of radionuclides and their regulation are treated in Chapter 6. The disinfection process and its resultant disinfection by-products are presented in Chapter 7. The contaminant selection process and the additional contaminants to be regulated by 1989 and 1991 and in future years are discussed in Chapters 8 and 9. EPA's Office of Drinking Water's Health Advisory Program is explained in Chapter 10. The record of public water system compliance with the primary drinking water regulations is detailed in Chapter 11. Chapter 12 offers a nongovernmental perspective on the general quality of drinking water in the United States and how this is affected by a wide range of drinking water treatment technologies, with particular attention to the multifaceted public health challenges associated with disinfectant technologies and their possible by-products. (See W90-03731 thru W90-03740) (Lantz-PTT)

W90-03730

HISTORICAL DEVELOPMENT OF THE NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
C. D. Larson.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 3-15, 1 fig, 9 tab, 8 ref.

Descriptors: *History, *Regulations, *Drinking water, *Water treatment, *Legislation, Bacterial analysis, Standards, Public health, Safe Drinking Water Act, Human diseases, Water quality control.

History gives ample evidence of the inescapable penalties paid by past civilizations that failed to provide for the safety of their water systems. Modern history shows that such waterborne diseases as typhoid, dysentery, and cholera are controllable, and in fact were all but eliminated in the United States by the 1930s by applying the principles identified in what are commonly referred to as the U.S. Public Health Service (PHS) Drinking Water Standards of 1914 and 1925. In 1942 and 1946, the standards were revised to include provisions for the use of membrane filter procedures in the bacteriological examination of water samples. The National Community Water Supply Study completed in 1969 suggested a backslide in drinking water quality, with trends in waterborne disease suggesting the slide is not over, even though the Safe Drinking Water Act has been on the books since 1974. Waterborne disease outbreaks in Pennsylvania, Maine, and other locations, and organic chemical problems only partially foreseen by those involved in revising the 1962 PHS standards, have made safe, palatable drinking water an enormous challenge in the 1980s. (See also W90-03730) (Lantz-PTT)
W90-03731

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR VOLATILE ORGANIC CHEMICALS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
J. A. Cotruvo, and M. Regelski.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 29-34, 2 tab, 4 ref.

Descriptors: *Water treatment, *Drinking water, *Volatile organic compounds, *Primary Drinking Water Regulations, *Regulations, *Water quality control, Organic compounds, Standards, Solvents, Groundwater pollution, Vinyl chloride, Benzene, Trichloroethylene, Carbon tetrachloride, Dichloroethane, Dichlorobenzene, Dichloroethylene, Trichloroethane.

On July 8, 1987, the final rule was published for the National Primary Drinking Water Regulations (NPDWRs) in volatile organic chemicals (VOCs) and monitoring for unregulated contaminants. The setting of maximum contaminant levels (MCLs) for the eight VOCs in this rule (plus fluoride, promulgated April 6, 1986), satisfied the statutory deadlines in the Safe Drinking Water Act of 1974 (SDWA) in regard to completing the establishment of the first nine MCLs within 12 months. The eight synthetic VOCs in this rule are widely used as unleaded gas additives, household cleaning solutions, solvents for removing grease, air fresheners, and mothballs. They are found frequently in drinking water from groundwater sources. All have relatively low boiling points and vaporize readily. The respective maximum contaminant level goals (MCLGs) and MCLs for these eight VOCs are as follows: vinyl chloride--zero, 0.002; benzene--zero, 0.005; trichloroethylene--zero, 0.005; carbon tetrachloride--zero, 0.005; 1,2-dichloroethane--zero, 0.005; para-dichlorobenzene--0.075, 0.075; 1,1-dichloroethylene--0.007, 0.007; and 1,1,1-trichloroethane--0.2, 0.2. (See also W90-03730) (Lantz-PTT)
W90-03733

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR SYNTHETIC ORGANIC CHEMICALS, INORGANIC CHEMICALS, AND MICROBIOLOGICAL CONTAMINANTS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
J. A. Cotruvo, and M. Regelski.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 35-43, 2 tab.

Descriptors: *Primary Drinking Water Regulations, *Organic pollutants, *Inorganic compounds, *Microorganisms, *Water quality control, *Regulations, *Standards, *Water treatment, *Drinking water, Viruses, Human diseases, Disinfection, Giardia, Coliforms, Filtration.

Thirty synthetic organic chemicals and 10 inorganic chemicals are included with Phase II of the National Primary DRinking Water Regulations. These 40 chemicals represent a widely varied group of contaminants, each with its unique contamination problem. The synthetic organics may be found where there is manufacturing; pesticides, where there is agricultural development; and the inorganics, both in natural geologic formations and in treatment and conveyance mechanisms for drinking water supplies and sources. Phase II regulatory goals satisfy the statutory requirements of the Safe Drinking Water Act of 1974 (SDWA) and Amendments to set 40 maximum contaminant level goals (MCLGs) and 40 maximum contaminant levels (MCLs) plus the monitoring of 51 contaminants by June 1988. Microbials will be handled concurrently with filtration criteria for an expected promulgation date of June 1988. Proposed surface water treatment/filtration regulations set criteria for the states to determine which water systems will have to install filtration or update existing filtration facilities and/or disinfect: all surface water systems will now have to disinfect; all surface water systems must filter unless they meet source water quality criteria and site specific conditions; and only qualified operators will be entitled to operate the systems. All systems will need to achieve at least 99.9% removal and/or inactivation of Giardia cysts and 99.9% removal and/or inactivation of enteric viruses. Filtration is not required if: a system meets source water quality criteria (coliform and turbidity levels): and, a system meets the following site specific conditions--(1) has disinfection which achieves 99.9% and 99.99% inactivation of Giardia cysts and viruses; (2) maintains watershed control/satisfies sanitary survey requirements; (3) has no history of waterborne disease outbreak without making treatment corrections; (4) complies with long-term coliform MCL; (5) meets with total trihalomethanes MCL. (See also W90-03730) (Lantz-PTT)
W90-03734

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR RADIONUCLIDES.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
E. V. Ohanian.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 45-55, 8 tab, 3 ref.

Descriptors: *Primary Drinking Water Regulations, *Radioisotopes, *Drinking water, *Standards, *Water treatment, *Water quality control, Radium radioisotopes, Radon radioisotopes, Uranium radioisotopes, Radium, Uranium, Radon, Regulations.

In 1976, the EPA promulgated the National Interim Drinking Water Regulations (NIPDWR). The Safe Drinking Water Act (SDWA) of 1974, as amended in 1986, requires that the EPA now promulgate the National Revised Primary Drinking Water Regulations (NRPDWR). Revised regulations are developed in two steps by establishing maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs). Under the 1986 Amendments to the SDWA, these two values are published concurrently for each contaminant--first as proposed regulations and then as final regulations. The NL1PDWRs include both natural and man-made radionuclides. The standards for natural radionuclides include a gross alpha particle standard of 15 pCi/L and a combined 226-Ra and 228-Ra standard of 5 pCi/L. Both radon and uranium are specifically excluded from the gross alpha particle activity because of lack of data and information concerning their occurrence and toxicity. The interim standard for man-made radionuclides is a total dose equivalent of 4 millirems/yr. The MCLGs under development for radionuclides include values for 226-Ra and 228-Ra separately, natural uranium, 222-Rn, gross alpha particle activity and man-made radionuclides. All are estimated to pose carcinogenic risks to humans. A summary of the information compiled to date by the EPA toward development of the NRPDWRs for radionuclides is summarized. Emphasis is given to information available for radium, uranium, and radon, as these are the radioisotopes of primary concern with regard to current regulatory efforts. (See also W90-03730) (Lantz-PTT)
W90-03735

ISSUES IN DEVELOPING NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR DISINFECTION AND DISINFECTION BY-PRODUCTS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
J. A. Cotruvo, and M. Regelski.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 57-69, 1 tab, 43 ref.

Descriptors: *Water treatment, *Standards, *Primary Drinking Water Regulations, *Disinfection, *Water quality control, *Drinking water, Disinfectants, Chlorides, Chlorine dioxide, Chloramine, Ozone, Organic compounds, Regulations.

The EPA is required to specify criteria for the disinfection of public water supplies. A number of issues need to be addressed, and further data on the health effects of disinfectants and their by-products are needed before the EPA can specify such criteria. Major issues to be addressed include the potential relationship of the three main disinfectants--chlorine, chlorine dioxide, and chloramine--to cardiovascular disease. For many disinfectants and disinfection by-products, the short-term toxicity has been well characterized. Ozone, however, is one disinfectant for which no toxicity studies are available. Studies have been performed on its by-products; ozone is unstable and does not persist in water to the consumer's tap. Longer term studies are needed for the chlorinated acids, aldehydes, alcohols and ketones, haloacetonitriles, cyanogen chloride, chloropicrin, brominated trihalomethanes (THMs), chlorine, chlorine dioxide, chlorite, and chlorate. Other issues needing to be given attention include the consequences of the sequencing of disinfectants in the water treatment process. This needs to be studied so that water quality is highest at the lowest risk to health of by-products of disinfection. Promulgation of regulations for these substances is extremely complicated. EPA must keep in mind not only the chemical reactions, toxicology of health effects, benefits of these compounds in controlling microorganisms and in controlling pathogenic disease outbreaks, treatment techniques, and cost feasibilities when trying to set regulatory standards. (See also W90-03730) (Lantz-PTT)
W90-03736

NATIONAL PRIMARY DRINKING WATER REGULATIONS FOR ADDITIONAL CONTAMINANTS TO BE REGULATED BY 1989.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
E. V. Ohanian.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 71-82, 1 fig, 3 tab.

Descriptors: *Water treatment, *Standards, *Water quality control, *Primary Drinking Water Regulations, *Regulations, Inorganic compounds, Organic compounds, Human diseases, Risk assessment, Disinfectants, Volatile organic compounds, Microorganisms, Radioisotopes, Standards.

The Safe Drinking Water Act (SDWA) of 1974 requires the EPA to publish National Primary Drinking Water Regulations (NPRDWRs) for contaminants that may pose adverse human health effects. The 1986 Amendments to the SDWA state that: (1) EPA must propose and promulgate maximum contaminant level goals (MCLGs)(unenforceable health goals) and maximum contaminant levels (MCLs)(enforceable standards) simultaneously; (2) EPA must regulate 9 contaminants within one year of enactment, another 40 within two years, and 34 additional contaminants within three years (for a total of 83); (3) EPA has the option of substituting up to seven other contaminants for those listed by Congress if it finds this will provide greater health protection; (4) in addition to the 83 contaminants, at least 25 more primary drinking water standards will be required by 1991, with 25 more standards expected every three years thereafter; (5) EPA must prepare a report to Congress on comparative health risks of raw water contamination versus contamination by treatment chemicals (e.g., disinfection by-products) within 18 months of enactment. These contaminants all fall into five broad categories: (1) volatile organic chemicals, inorganics, microbials and turbidity, organics and radionuclides. Drinking Water Criteria Documents (CDs) have been or are being prepared for each contaminant to be regulated. These provide the health effects basis to be considered in establishing the MCLG. To achieve this objective, data on pharmacokinetics, human exposure, acute and chronic toxicity to animals and humans, epidemiology, and mechanisms of toxicity are evaluated. Specific emphasis is placed on literature data providing dose-response information. (See also W90-03730) (Lantz-PTT)
W90-03737

OFFICE OF DRINKING WATER'S HEALTH ADVISORY PROGRAM.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
E. V. Ohanian.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 85-103, 2 fig, 8 tab.

Descriptors: *Drinking water, *Information exchange, *Water quality control, *Public health, *Water treatment, *Standards, Technology transfer, Regulations.

The Office of Drinking Water's (ODW) Health Advisory (HA) Program provides information on health effects, analytical methodology and treatment technology that would be useful in dealing with the contamination of drinking water. Health Advisory documents include nonregulatory concentrations of contaminants in drinking water at which adverse effects would not be anticipated to occur over specific durations of exposure. A margin safety is included in the HA values to protect sensitive members of the population. The HA values are not legally enforceable federal standards. They are subject to change as new and better information becomes available. The HAs are offered as informal technical guidance to assist federal, state and local officials responsible for the protection of public health. Although not a formal component of ODW's regulatory program, the information assembled under the HA Program has a major impact on the identification of contaminants that should be given priority for future regulation. Thus, the HA Program constitutes a vital role in ODW's efforts to meet the regulatory requirements of the SDWA. The HA Program also serves as ODW's primary technology transfer mechanisms to health officials and the public on the health effects of drinking water contamination. (See also W90-03730) (Lantz-PTT)
W90-03738

COMPLIANCE BY PUBLIC WATER SUPPLY SYSTEMS WITH NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
P. C. Karalekas, and J. R. Trax.
IN: Safe Drinking Water Act: Amendments, Regulations and Standards. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 105-112, 4 fig, 5 tab.

Descriptors: *Water treatment, *Primary Drinking Water Regulations, *Drinking water, *Water quality control, Regulations, Public policy, Public health, Compliance, Governmental interrelations.

Since the passage of the original Safe Drinking Water Act (SDWA) in 1974, the EPA has tracked the compliance by public water supply systems with the National Primary Drinking Water Regulations (NPDWR). EPA receives reports from the states with primary enforcement responsibility of all violations of the NPDWR and these violations are incorporated into the Federal Reporting Data System (FRDS). Of the 57 states and territories that are included in the public water systems supervision program under the SDWA, 54 have been granted primary enforcement responsibility, with 3 programs being administered directly by EPA regional offices. In addition to information on violations, quarterly reports are submitted to EPA on the basic characteristics of public water systems (PWS) such as population served, source of supply, and treatment, which is called the inventory of public water systems and is also incorporated into FRDS. These data indicate a very high level of compliance by most categories of water systems. The so-called small system problem is evident, with most violations occurring in the very small systems. Despite the efforts to focus attention and resources on these small systems, this problem is likely to persist as new regulations are promulgated. (See also W90-03730) (Lantz-PTT)
W90-03739

DRINKING WATER QUALITY AND WATER TREATMENT PRACTICES: CHARTING THE FUTURE.
Massachusetts Univ., Amherst. Div. of Public Health.
For primary bibliographic entry see Field 5F.
W90-03740

OECD ENVIRONMENTAL DATA: DONNEES OCDE SWR L'ENVIRONMENT, COMPENDIUM 1989.
Organization for Economic Co-Operation and Development, Paris (France).
For primary bibliographic entry see Field 10C.
W90-03742

TECHNICAL SUPPORT DOCUMENT: LANDFILLING OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5E.
W90-03744

TECHNICAL SUPPORT DOCUMENT: SURFACE DISPOSAL OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5E.
W90-03745

DRINKING WATER HEALTH ADVISORY: PESTICIDES.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 819 p.

Descriptors: *Health Advisories, *Pesticides, *Drinking water, *Public health, Organic compounds, Diazinon, Diuron, Picloram, Propazine, Trifluralin, Endothall.

Health Advisories (HAs) are prepared by the Criteria and Standards Division, Office of Drinking Water (ODW) of the U.S. EPA. Documents summarized in this volume are part of the Health Advisory Program sponsored by ODW in response to the public need for guidance during emergency situations involving drinking water contamination. They provide technical guidance to public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. Each HA summarizes available data concerning the occurrence, pharmacokinetics, and health effects of a specific contaminant or mixture, as well as analytical methods and treatment technologies for the contaminant: acifluorfen, ametryn, ammonium sulfamate, atrazine, Baygon, bentazon, bromacil butylate, carbaryl, carboxin, chloramben, chlorothalonil, cyanazine, Dalapon, DCPA, Diazinon, dicamba, 1,3-dichloropropene, Dieldrin, Dimethrin, Dinoseb, Diphenamid, Disulfoton, Diuron, Endothall, ethylene thiourea, Fenamiphos, Fluometuron, Fonofos, glyphosate, hexazinone, maleic hydrazide, MCPA, methomyl, methyl parathion, metolachlor, metribuzin, Paraquat, Pilcoram, prometon, Pronamide, Propachlor, Propazine, Propham, Simazine, tebuthiuron, Terbacil, Terbufos, 2,4,5-trichlorophenoxyacetic acid, Trifluralin. The health effects data are used to estimate concentrations of the contaminant in drinking water that are not anticipated to cause any adverse noncarcinogenic health effects over a specific exposure duration. These HA concentrations include a margin of safety to protect sensitive members of the population (e.g., children, the elderly, pregnant women). Health Advisories are used only for guidance and are not legally enforceable. They are subject to change as new information becomes available. (Lantz-PTT)
W90-03747

SUPERFUND RECORD OF DECISION: CALIFORNIA GULCH, CO.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-153714. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R08-88/020, March 1988. 152p, 5 fig, 4 tab, 4 append.

Descriptors: *Site remediation, *Cleanup operations, *Water pollution treatment, *Water pollution sources, *Superfund, *California Gulch, *Colorado, *Arkansas River, Heavy metals, Cadmium, Copper, Lead, Zinc, Monitoring, Costs, Groundwater pollution, Sediment contamination.

The California Gulch site is located in Lake County, Colorado, approximately 100 miles southwest of Denver. The study area for this first remedial action encompasses an 11.5 sq m watershed, which includes the city of Leadville, that drains along California Gulch to the Arkansas River. Between 1859 and 1986, the area was extensively mined for gold, lead, silver, copper, zinc and manganese. Because of these mining operations, the Yak Tunnel was constructed to dewater mines and facilitate mineral exploration and development. Studies indicate that the Yak Tunnel discharges a combined total of 210 tons/yr of cadmium, lead, copper, manganese, iron, and zinc into California Gulch, which drains into the Arkansas River. Both California Gulch and the Arkansas River are used by the public for recreation, and the Arkansas River is heavily used for irrigation, livestock watering, public water supply an fisheries as well. Surface water contamination is the major impact of the Yak Tunnel discharge. Heavy metal migration through surface water has also caused groundwater and sediment contamination. Primary contaminants of concern affecting the surface water, sediments, and groundwater are cadmium, copper, lead and zinc. The selected remedial action for this site includes: construction of surge ponds at the portal of Yak Tunnel to protect the California Gulch site and the Arkansas River from accidental release of acid water, sludge, and sediments; construction of concrete plugs at locations in the tunnel to reduce migration of contaminated water and reduce the extraction of metals from raw mineral ore; sealing shafts and drill holes, diversion of surface water away from tunnel recharge areas, and grouting of highly fractured rock; implementation of a monitoring program to detect leaks, seeps or migration of contaminated groundwater; and installation of an interim treatment plant to treat groundwater, which will be pumped to control surface seeps and migration of contaminated surface water. The estimated capital cost of the selected remedy is $11,982,770 with annual operation and maintenance costs of $460,307. (Author's abstract)

W90-03750

SUPERFUND RECORD OF DECISION: BRIO REFINING, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-153720. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/031, March 1988. 72p, 6 fig, 4 tab, 8 ref.

Descriptors: *Site remediation, *Aromatic compounds, *Chlorinated hydrocarbons, *Water pollution treatment, *Cleanup operations, *Superfund, *Water pollution sources, Houston, Texas, Costs, Excavation, Incineration, Biological treatment, Volatile organic compounds, Dichloroethane, Trichloroethane, Methylene chloride, Organic compounds, Solvents, Naphthalene, Kerosene, Phenanthrene, Fluoranthene.

The 58-acre Brio Refining site is located in Harris County, Texas, approximately 20 miles southeast of Houston. Between 1957 and 1982 the site refined crude oil and styrene tars to produce toluene, ethylbenzene, aromatic solvents, naphthalene, diesel fuel and kerosene. Various owners of the site stored styrene tars in 24 open pits. Other waste products and sludges were stored in aboveground tanks. Site investigation indicate that between 500,000-700,000 cu yd of onsite soil have measurable contamination, and that high levels of volatile organic compounds (VOCs) exist in groundwater underlying the site. Primary contaminants of concern affecting the soil and groundwater are VOCs including 1,1-dichloroethane, 1,1,2-trichloroethane, and methylene chloride; and base/neutral organic compounds including phenanthrene and fluoranthene. The selected remedial action for the Brio Refining site includes: excavation and incineration or biological treatment of all onsite soils, sludges, and liquids found to be above action levels defined in the Endangerment Assessment, with backfilling of all treated material passing the Toxicity Characteristic Leaching Procedure (TCLP). The estimated present worth cost of this remedial action is $23,308,000-$23,333,000 for biological treatment or $22,458,000-$26,598,000 for incineration based on 62,900 cu yd of treatable material. (Author's abstract)
W90-03751

SUPERFUND RECORD OF DECISION: NINTH AVENUE DUMP, IN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-143837. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-88/071, September 1988. 33p, 4 fig, 2 tab, append.

Descriptors: *Site remediation, *Cleanup operations, *Superfund, *Water pollution sources, *Landfills, *Water pollution treatment, Gary, Indiana, Organic compounds, Volatile organic compounds, Benzene, Toluene, Xylene, Polycyclic aromatic hydrocarbons, Polychlorinated biphenyls, Heavy metals, Cyanide, Costs, Separation, Extraction, Groundwater pollution, Monitoring.

The Ninth Avenue Dump (NAD) is a 17-acre inactive chemical and industrial waste disposal site located in a low-lying area with poor drainage in Gary, Indiana. The site accepted dry industrial, construction and demolition waste, oil, solvents, paint solvents and sludges, resins, and flammable, caustic and arsenic-contaminated materials. A small-scale auto wrecking operation was reportedly observed at the property in 1975 by the Indiana State Board of Health (ISBH) as well as the presence of 10,000 55-gallon drums at the site, many of which were empty. Additionally, the ISBH estimated that approximately 500,000 gallons of liquid industrial waste and 1,000 buried drums were present at the site. Subsequent inspection revealed discarded auto batteries, drummed liquid wastes, and abandoned tanker trucks. In 1975 and 1980 EPA ordered the site operator to initiate surface cleanups. Subsequently, he removed some barrels, junk cars, and trucks. This first operable unit addresses remediation of an oil layer floating on the groundwater surface, the principal environmental threat at the site. It is estimated that there are 250,000 to 700,000 gallons of oil under the site, of which 100,000 to 500,000 gallons may be recoverable. Several organic and inorganic contaminants have been detected in the oil in higher concentrations than in other media. Oil seeps observed in onsite ponds lead to concerns that the oil may be affecting aquatic life, and an oil sheen has been seen on several surface water bodies. The second operable unit will address buried waste, contaminated soil, and contaminated groundwater. The primary contaminants in the oil layer include: volatile organic compounds, benzene, toluene, xylene, polycyclic aromatic hydrocarbons, organics, polychlorinated biphenyls, metals, and cyanides. The selected remedial action for this site includes: construction of a soil-bentonite slurry wall to completely surround the hydrocarbon layer; separate extraction of oil and groundwater through a series of central extraction wells, followed by storage of the recovered oil in an onsite storage tank and recharge of the treated groundwater through recharge wells; and groundwater monitoring. The estimated capital cost for this remedial action is $1,960,000 with annual operation and maintenance costs of $190,000. (Author's abstract)
W90-03752

TECHNICAL SUPPORT DOCUMENT: PATHOGEN/VECTOR ATTRACTION REDUCTION IN SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5D.
W90-03755

PUBLIC POLICY ON GROUND WATER QUALITY PROTECTION.
Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). 163 p. Edited by Waldon R. Kerns.

Descriptors: *Groundwater quality, *Public policy, *Groundwater pollution, *Water pollution prevention, *Conferences, Legal aspects, Groundwater management, Environmental protection, Management planning, Water quality standards.

The nation's groundwater resources are being degraded by a wide spectrum of sources and causes. Some are natural sources and causes, but many are due to man's activities. Although groundwater pollution has not received as much attention as surface water pollution, problems associated with it may be much more significant. This conference brought together, by invitation, a group of persons having recognized expertise in groundwater quality and a concern for related public policy issues. Through presentations and discussions, they considered such issues as: (1) the extent of degradation allowable, and ramifications associated with specific policies; (b) policies regarding various sources of contamination and their impact on groundwater quality; (c) the potential effectiveness and long-range implications of specific federal and state programs concerning groundwater quality protection; and (d) weaknesses in existing laws and administrative arrangements. (See W90-03772 thru W90-03789) (Lantz-PTT)
W90-03771

MAGNITUDE OF THE GROUND-WATER CONTAMINATION PROBLEM.
Robert S. Kerr Environmental Research Lab., Ada, OK. Ground Water Research Branch.
For primary bibliographic entry see Field 5B.
W90-03772

NON-DEGRADATION AS A GROUND-WATER QUALITY POLICY.
National Audubon Society, New York.
R. C. Rhindress.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 11-14.

Descriptors: *Water pollution prevention, *Water policy, *Groundwater quality, *Groundwater pollution, *Public policy, Aquifers, Public opinion, Soil absorption capacity, Attitudes, Education, Water quality trends, Groundwater depletion, Potable water, Water pollution control.

Professional policy choices are hollow statements without public acceptance; that acceptance must rest on a foundation of understanding. Therefore, before any policy about groundwater can be formed or implemented, there must exist a clear understanding of the system called groundwater. The general public's understanding of groundwater is a realm of myth and misunderstanding. An educated public, knowing some realities of groundwater pollution and production, certainly will support a non-degradation policy. Since the utility of groundwater is limited both by quality and quantity, degradation is any negative influence on either characteristic. A non-degradation policy is needed because groundwater is an essential natural resource; a resource which has been vital to the establishment of much of America. In forming a policy, the following three issues must be considered: (1) Certain aquifers and soil systems have great adsorptive and attenuative capacities with respect to many water pollutants. (2) Although there is a lot of talk about contaminated groundwater, very little is said about contaminated aquifers; groundwater quality is not simply a matter of water quality, but of aquifer quality as well; (3) People who come from areas where groundwater quality is naturally high, tend to be locked into the concept of 'potable groundwater for direct human consumption;' but, no matter what the ambient quality, there are instances where the arguments for preservation of groundwater quality still hold. (See also W90-03771) (Lantz-PTT)
W90-03773

LIMITED DEGRADATION AS A GROUND-WATER QUALITY POLICY.
Army Armor Center, Fort Knox, KY.
J. L. Boren.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 15-19.

Descriptors: *Water policy, *Waste management, *Water quality control, *Groundwater quality, *Land disposal, Connecticut, Public policy, Site selection, Water reuse, Leachates, Recycling, Decision making, Environmental protection.

The Connecticut Solid Waste Management program has two primary goals: (1) to protect the environment from the hazards that come from land disposal of residuals, and (2) to realize and implement the opportunity that recovery of components from the waste stream represents. To attain these goals, it must be recognized that in materials needing to be disposed of, there are substances which will contaminate the groundwater, along with unknown substances which will exist in leachate. Connecticut, a leader in resources recovery, readily acknowledges that total recycle or reuse of many residuals is not a presently available technological alternative to an obvious need to dispose of such materials. Consequently, land disposal is the practical alternative which must be employed to fulfill the need. The problem facing the public decision maker is to find an acceptabale location of the disposal. The problem is not to establish in absolute terms that no water will be contacted by pollutants, for that would be impossible. Rather, it is to establish with reasonable certainty that no water which is contacted by pollutants will be significantly altered to preclude existing or reasonable anticipated use by persons or to interfere with the physical, chemical or biological integrity of waters in direct contact with living organisms. The

interpretation of this policy is very clearly that of limited degradation. (See also W90-03771) (Lantz-PTT)
W90-03774

SURFACE AND SUBSURFACE MINING: POLICY IMPLICATIONS.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Div. of Mine Drainage Control and Reclamation.
D. R. Thompson.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 22-29, 12 ref.

Descriptors: *Public policy, *Water pollution prevention, *Pennsylvania, *Coal mining, *Water pollution control, *Strip mines, *Water law, *Acid mine drainage, Path of pollutants, Clean Streams Law, Surface Mining Conservation and Reclamation Act, Mine drainage, Acid streams, Leaching, Diversion ditches, Strip mine wastes, Backfill, Water pollution control, Stream pollution, Sulfuric acid, Sulfates, Groundwater movement, Groundwater pollution, Iron.

Existing Pennsylvania policies are based on the Clean Streams Law and the Surface Mining Conservation and Reclamation Act. The primary reason for passage of these laws was to prevent pollution of the state's streams due to acid mine drainages from underground and surface coal mines. Although the Clean Streams Law has been on the legislative books since 1937, it was not until an amendment in 1945 to this act that mining was covered. For mines which had acid water, operators could discharge to acid streams but not to designated clean streams. By 1951, it was recognized that surface water flows must be diverted away from surface mines by ditches. Then the Sanitary Water Board adopted rules and regulations concerned with the disposal of acid-forming refuse from strip mines. In 1964, the strongest backfilling law in the United States went into effect. This became a major contribution to the control of pollution from surface mines which produce acid drainage. By 1970, the legislature ruled that underground mines must be sealed watertight upon closure. The problem of maintaining water quality around mines is caused by the exposure of the acid bearing material to the atmosphere and the leaching of flowing groundwater. Iron and sulfates are leached out and form the sulfuric acids, which are transported to the streams by surface drainage and groundwater. In anthracite fields, it is difficult to determine the impact on groundwater. Surface drainage is almost non-existent and the subsurface mines control groundwater flows through a maze of tunnels which interconnect these mines. The drainage reaches streams via flows to outfalls strategically located at the lowest surface levels of the basins. Some basins are interconnected by tunnels capturing flows which divert the groundwater from one basin to another. (See also W90-03771) (Lantz-PTT)
W90-03775

ABANDONED WELLS, INJECTION WELLS, AND SALTWATER INJECTION: POLICY IMPLICATIONS.
Texas Water Quality Board, Austin. Geological Services Section.
For primary bibliographic entry see Field 5E.
W90-03776

OIL WELL OPERATION/MAINTENANCE AND SALTWATER INTRUSION: POLICY IMPLICATIONS.
Cities Service Oil Co., Charleston, WV.
For primary bibliographic entry see Field 5B.
W90-03777

IMPOUNDMENTS FOR LIQUID WASTES: POLICY IMPLICATIONS.
Maryland Water Resources Administration, Annapolis.
For primary bibliographic entry see Field 5E.
W90-03778

AGRICULTURAL PRACTICES: POLICY IMPLICATIONS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 5C.
W90-03779

URBAN LAND USE PRACTICES: POLICY IMPLICATIONS.
American Inst. of Planners, Washington, DC.
H. F. Wise.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 66-74, 2 ref.

Descriptors: *Urban hydrology, *Urban areas, *Urban planning, *Land use, *Water management, *Water policy, *Nonpoint pollution sources, Environmental impact, Regional planning, Social aspects, Economic aspects, Urban runoff, Storm runoff, Groundwater pollution, Water pollution control, Phosphorus, Eutrophication, Biochemical oxygen demand.

Management of urban growth became necessary as the costs of urban services began to get out of hand. Regional planning for water quality management requires an annually updated, five-year capital budget for sewage collector systems and treatment works. The expenditure of these funds induces and directs growth, as well as assists in meeting water quality standards. An environmental, social, and economic impact assessment must be prepared on each area-wide water quality management plan. The program would require that each city and county comprehensive and land use plan be adjusted annually to conform to the Council of Government's (COG) statement of regional needs. Special purpose districts would also be instructed to conform their annual budgets, covering operating and capital outlay, to the COG's Statement of Regional Needs. Around the country, the full implications of nonpoint source contributions of pollutants to the quality of the streams and lakes of the nation are just becoming realized. In the Atlanta metropolitan area, a Corps of Engineers Urban Studies Program done under the sponsorship of the State of Georgia and the Atlanta Regional Commission found in 1974 and 1975 that 45% of the biological oxygen demand (BOD) and 95% of the suspended solids in the region's waters comes from nonpoint sources--from stormwater runoff in urban areas. In the Baltimore Metropolitan Area, it has been found that the municipal water supply reservoirs are reaching a state of eutrophication. Over 75% of the phosphorus loads in these reservoirs comes from nonpoint source runoff. Containment of settlement, planning in an environmentally sensitive manner, respect for and protection of aquifer recharge areas, management of the runoff that flows into the streams and lakes--all these are things that have not been done on a regular and doctrinaire basis before. (See also W90-03771) (Lantz-PTT)
W90-03780

LAND APPLICATION OF WASTEWATER AND RESIDUALS: POLICY IMPLICATIONS.
Martin (A. W.) Associates, Inc., King of Prussia, PA.
For primary bibliographic entry see Field 5E.
W90-03781

UNDERGROUND INJECTION PROGRAM UNDER THE NATIONAL SAFE DRINKING WATER ACT.
New Mexico State Univ., Las Cruces.
J. W. Hernandez.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 92-101.

Descriptors: *Underground waste disposal, *Water pollution prevention, *Regulations, *Waste disposal, *Injection wells, *Safe Drinking Water Act, Legislation, Permits, Disposal wells, Drainage wells.

Section 1424(2) of the Safe Drinking Water Act states that EPA may, on its own initiative or on petition, find that an area has an aquifer which is the sole or principal drinking water supply and that a significant hazard to public health would result from a subsurface disposal system. Once such a determination is made and published, no commitment for federal financial assistance (grants, contracts, loan guarantee, or other) may be made by a federal agency for any project which EPA finds may result in contamination of the area's aquifer and create a significant hazard to public health. Prior to the issuance of the Underground Injection Control (UIC) regulations, EPA had sought the Safe Drinking Water Act Advisory Council's input on various facets of public policy associated with the anticipated control program. Draft regulations were submitted to working groups and to outside consultants. When finally issued on August 31, 1976, some of the principal provisions of the proposed UIC regulations were: (1) Types of well injections controlled; (2) Permitting of existing disposal wells; (3) Permitting of new disposal wells; (4) Requirements for disposal wells; and (5) Requirements applicable to all drainage wells. (See also W90-03771) (Lantz-PTT)
W90-03782

IMPACT OF FEDERAL LEGISLATION OTHER THAN THE SAFE DRINKING WATER ACT ON GROUND-WATER PROTECTION.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
R. K. Ballantine.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 102-112, 1 ref.

Descriptors: *Legal aspects, *Groundwater quality, *Legislation, *Federal jurisdiction, *Water pollution prevention, Water rights, Federal Water Pollution Control Act, Toxic Substances Control Act, Resource Conservation and Recovery Act, Federal Insecticide Fungicide and Rodenticide Act, Federal Environmental Pesticide Control Act, Atomic Energy Act, Environmental Policy Act.

This paper presents a quick overview of much of the federal legislation impacting environmental control, with a focus on groundwater quality protection, where that is specifically identified within the Acts. This legislation includes the: (1) Federal Water Pollution Control Act Amendments of 1972; (2) Toxic Substances Control Act; (3) Resource Conservation and Recovery Act of 11972; (4) Federal Insecticide, Fungicide, and Rodenticide Act; (5) Federal Environmental Pesticide Control Act of 1972; (6) Atomic Energy Act of 1954; and (7) National Environmental Policy Act of 1969. There are other statutes which have some bearing on groundwater quality protection--for example, court interpretations of statutes protecting Indian water rights, executive orders, and control of groundwater quality protection on Federal lands and Federal facilities. It would appear that, for most situations in which federal action is involved, some consideration of groundwater quality is authorized. (See also W90-03771) (Lantz-PTT)
W90-03783

STATE APPROACH TO GROUND-WATER PROTECTION: THE PENNSYLVANIA EXPERIENCE.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Ground Water Section.
C. W. Westlund.
IN: Public Policy on Ground Water Quality Pro-

tection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 113-118.

Descriptors: *State jurisdiction, *Regulations, *Groundwater quality, *Water pollution prevention, *Pennsylvania, Clean Streams Law, Water quality control, Information exchange, Groundwater use, Case studies, Groundwater mining.

The Clean Streams Law of Pennsylvania is the basis for rules and regulations to protect both surface and groundwaters. This program which began in 1963 as a part of the state's water pollution control program has grown considerably as the problems and needs were presented and understood. Wastewater treatment project reviews include consideration of the groundwater element. The groundwater protection program in Pennsylvania encompasses two main areas of activity: (a) groundwater pollution abatement, and (b) groundwater pollution prevention. In addition, the groundwater staff performs geohydrologic reviews and provides technical advice to other state programs which have an effect on groundwater quality. At present there is no legal remedy for regulating groundwater use. Excessive groundwater withdrawal, especially dewatering activities and high-production wells, can result in groundwater mining and interferences and can have a deleterious effect on quality. (See also W90-03771) (Lantz-PTT)
W90-03784

STATE APPROACH TO GROUND-WATER QUALITY PROTECTION: THE ILLINOIS EXPERIENCE.
Illinois State Environmental Protection Agency, Springfield. Div. of Land Pollution Control.
J. S. Moore.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 119-123.

Descriptors: *State jurisdiction, *Water pollution prevention, *Illinois, *Waste disposal, *Groundwater quality, *Regulations, Water quality control, Landfills, Land disposal, Illinois Pollution Control Act, Legislation, Injection wells, Liquid wastes, Hazardous wastes, Waste recovery, Underground waste disposal.

Historically, before the advent of the Illinois Pollution Control Act of 1970, the state had the authority to register, but not permit, disposal sites. After 1970, the state began developing, under its new powers, solid waste rules and regulations. By 1974, Illinois, by participating in Operation 5,000, a federal program to eliminate the many open dumps throughout the United States, and on its own initiative, had closed nearly 800 of these open burning garbage dumps. Continuing in these efforts has reduced the number of sites to approximately 400 sanitary landfill sites throughout the state. These sites are handling more than 8 million tons of domestic refuse per year. Illinois allows liquid and special waste to be incorporated into solid waste landfills in a few selected sites. The Agency has recently developed new criteria for the land disposal of special waste. These new criteria have been developed not only for the policy of protecting groundwater resources, but with the recognition that pre-treatment of waste must be accomplished to the highest degree practicable; that recovery, recycling, and reuse must be encouraged to the greatest degree, and that a realistic source of disposal be made available for these materials. To allow for the disposal of these materials and to assume the responsibility for the materials that are generated in Illinois, a number of land disposal methods which are being used: (a) direct sanitary landfilling; (b) subsurface injection; (c) surface absorption; (d) consignment burial; and (e) land spreading. (See also W90-03771) (Lantz-PTT)
W90-03785

ROLE OF INTERSTATE COMMISSIONS IN GROUND-WATER PROTECTION: THE SUSQUEHANNA RIVER BASIN COMMISSION PERSPECTIVE.
Susquehanna River Basin Commission, Mechanicsburg, PA.
For primary bibliographic entry see Field 6E.
W90-03786

CONVIVIAL TECHNOLOGY AS A LOCAL APPROACH TO GROUND-WATER PROTECTION: THE CHRISTINA RIVER BASIN EXPERIENCE.
Pennsylvania Univ., Philadelphia. Center for Ecological Research.
J. Tourbier.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 130-142, 14 fig, 8 ref.

Descriptors: *Urban planning, *Water quality control, *Management planning, *Groundwater quality, Decision making, Infiltration, Urban runoff, Groundwater recharge, Water costs, Christina River Basin, Water supply, Community development, Groundwater potential, Environmental impact, Social aspects.

In order to implement groundwater resources protection concerns on the local level, solutions and regulations have been developed that make sense to the local solicitor, municipal engineer, city planner, local official, and special interest groups in a community. The local regulatory approach is the adoption of a surface and groundwater drainage code. This was the step taken in the Christina Basin in New Castle County, Delaware. Under natural conditions in Delaware, approximately 10% of the total precipitation runs off, approximately 40% evaporates or is transpired by plants, and approximately 50% infiltrates into the ground. Contaminated runoff is purified by microbes linked to plants and contained in soil, and is filtered as it seeps into the ground. Problems of reduced infiltration have clear cost implications. Under natural conditions 20,000 acre-ft/yr or 55 acre-ft/day are infiltrating the aquifer in the Christina Basin. Approximately 9,000 acres may be lost to urban development until water supply problems become serious. At this point, the best plan is to allow development, providing protection measures are taken to keep infiltration at its natural level. To be compatible with a surface water reservoir, groundwater development should not cost more than $60/acre-ft or $876,000 for the full 13 million gallons per day (mgd) capacity of the Potomac Formation. It is recommended that municipalities expand the review procedure to require that developers analyze alternative technical solutions for the reduction of potentially adverse environmental impacts, and that this process include the following steps: (1) alternative technology defined; (2) construction aspects; (3) operation and maintenance; (4) social implications; and (5) values, standards, and acceptable impacts. (See also W90-03771) (Lantz-PTT)
W90-03787

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER COMMISSION VIEW.
Camp, Dresser and McKee, Inc., Belmont, CA. Water Resources Div.
For primary bibliographic entry see Field 6E.
W90-03788

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER WELL ASSOCIATION VIEW.
National Water Well Association, Worthington, OH.
For primary bibliographic entry see Field 6E.
W90-03789

PETROLEUM CONTAMINATED SOILS. VOLUME I: REMEDIATION TECHNIQUES, ENVIRONMENTAL FATE, RISK ASSESSMENT.
Lewis Publishers, Inc. Chelsea, Michigan. 1989. 357 p. Edited by Paul T. Kostecki, and Edward J. Calabrese.

Descriptors: *Oil pollution, *Soil contamination, *Cleanup operations, *Regulations, *Fate of pollutants, Conferences, California, New Jersey, Model studies, Waste stabilization, Land disposal, Risk assessment, Management planning, Policy making.

While petroleum contaminated soils emerged as a major domestic environmental issue in the early 1980s, soil has had the potential for contamination by petroleum products since this country began large-scale production, transportation, storage, and use of petroleum products. Petroleum contamination had been largely perceived as a groundwater contamination problem prior to the early 1980s. However, as public concern and scientific understanding grew, it became clear that the soil component had to be addressed if meaningful solutions were to be found. This book, the proceedings of the Second National Conference on the Environmental and Public Health Effects of Soils Contaminated with Petroleum Products, which took place from September 28, 29 and 30, 1987. Part I of this book provides the insight and various perspectives on the scientific, economic, and regulatory issues as presented by representatives of the petroleum industry (API)(Chapter 1), state regulatory agencies, California (Chapter 2) and New Jersey (Chapter 4), utilities industry (EEI)(Chapter 3), and the federal government (EPA/Office of Underground Storage Tanks)(Chapter 5). Part II provides several chapters on environmental fate (Chapter 6), soil physics (Chapter 7), state-of-the-art models (Chapter 8), and the application of modeling to regulatory programs (Chapter 9). Part III provides information on a wide range of in situ and offsite remedial technologies that have been used, as well as some that show promise. More specifically, this section presents an overview of existing technologies (Chapters 10 and 18), as well as methodologies such as stabilization (Chapter 11), vitrification (Chapter 12), soil washing (Chapter 13), land treatment (Chapter 14), asphalt batching (Chapter 15), incorporation into bituminous concrete (Chapter 16), and low temperature stripping (Chapter 17). In Part IV the theory behind the rationale for using risk assessment (Chapters 19 and 20) is provided, as well as information for use in the health hazard and exposure components (Chapters 22 and 23) of the risk assessment. Several models are critiqued and alternatives are offered (Chapter 21). The utility of the models is demonstrated by proposing an implementation plan for state agencies (Chapter 24). (See W90-03831 thru W90-03847) (Lantz-PTT)
W90-03830

SOILS CONTAMINATED BY MOTOR FUELS: RESEARCH ACTIVITIES AND PERSPECTIVES OF THE AMERICAN PETROLEUM INSTITUTE.
American Petroleum Inst., Washington, DC.
For primary bibliographic entry see Field 5B.
W90-03831

STATE'S PERSPECTIVE OF THE PROBLEMS ASSOCIATED WITH PETROLEUM CONTAMINATED SOILS.
Orange County Div. of Environmental Health, CA. Hazardous Waste Management Section.
J. J. Hills.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 21-26.

Descriptors: *Cleanup operations, *California, *Oil pollution, *Soil contamination, *Fate of pollutants, Groundwater pollution, Path of pollutants, Hydrocarbons, Drinking water.

As a result of the 600-plus cleanups of petroleum contaminated soil overseen to date in California, it is concluded that a remedial action plan for petroleum contaminated sites is not complete unless the cleanup of soils contamination is addressed. There are those who believe that contaminated soil need

not be addressed as part of a site cleanup, and that only groundwater cleanup should be required. The author disagrees with this approach because of the following five problems that are associated with petroleum contaminated soils: (1) soil with significant petroleum contamination can act as a source of contamination for groundwater supplies; (2) significant concentrations of petroleum by-products in soil have been found to permeate polyvinyl chloride (PVC) water lines and contaminate drinking water supplies; (3) vapors from petroleum contaminated soils may migrate laterally and/or vertically and collect in underground utility vaults, sewer lines, and basements, creating serious fire or explosion hazards; (4) surface soils contaminated by petroleum by-products with nonbiodegradable additives such as lead are a potential source of ingestion by small children; and (5) those constituents of gasoline with high vapor pressures may migrate upward through the unsaturated zone presenting a potential source of contamination for surface waters and certain food crops being grown in the immediate proximity of the contaminated soil. In summary, actions must be taken in a practical and realistic manner by evaluating each site on a case-by-case basis in relation to these concerns when determining site cleanup levels. (See also W90-03830) (Lantz-PTT)
W90-03832

PROBLEMS DEALING WITH PETROLEUM CONTAMINATED SOILS: A NEW JERSEY PERSPECTIVE.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
R. K. Tucker.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 37-53, 3 ref.

Descriptors: *Waste disposal, *New Jersey, *Oil pollution, *Soil contamination, Landfills, Underground waste disposal, Legislation, State jurisdiction, Case studies.

The New Jersey experience reinforces the perspective of the complex nature of soil contamination. Petroleum products significantly contribute to such contamination; New Jersey's giant petrochemical industry, second largest in the nation, dominates the economy of this state. The magnitude of chemical use, and consequently the amount of waste products involved, is staggering. Because of soil contamination and subsequent groundwater problems, land disposal is no longer a viable option in New Jersey. Direct soil contamination from leaking underground tanks provides substantial amounts of petroleum pollutants. However, direct disposal of used oils on the ground by individuals or industries; seepage from landfills, illegal dumps, unlined pits, ponds, or lagoons; and spills from transport accidents or even auto accidents all make contributions to the soil burden. Indirect contamination through aerial transport plays a role in widely spreading pollutants, also contributing to soil residues. Complications of dealing with soil contamination include problems with sampling, detection, and analysis; determining fate and transport of individual components or mixtures; and evaluating actual exposure in order to be able to undertake valid risk assessments. The New Jersey Underground Storage of Hazardous Substances Act is patterned after the federal 'Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act. Both the federal and the state statutes require the registration of facilities, technical standards for new tanks, leak detection programs, remedial action for sites found to be contaminated, and financial responsibility. In addition, the state act, unlike the federal act, provides for a permit program for new tank installations, for Department of Environmental Protection approval of tank closures, for the annual reregistration of all facilities, and for a loan program to ease the economic burden for owners who replace their tanks. New Jersey examples of soil contamination are provided through seventeen case studies. (See also W90-03830) (Lantz-PTT)
W90-03833

FEDERAL UNDERGROUND STORAGE TANK REGULATIONS AND CONTAMINATED SOILS.
Environmental Protection Agency, Washington, DC. Office of Underground Storage Tanks.
For primary bibliographic entry see Field 5B.
W90-03834

AVAILABLE REMEDIAL TECHNOLOGIES FOR PETROLEUM CONTAMINATED SOILS.
Weston (Roy F.), Inc., Concord, CA.
L. Preslo, M. Miller, W. Suyama, M. McLearn, and P. Kostecki.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 115-125, 1 fig, 6 tab, 7 ref.

Descriptors: *Cleanup operations, *Oil pollution, *Soil contamination, In situ treatment, Volatilization, Biodegradation, Leaching, Land disposal, Solidification, Chemical treatment, Remedies.

The 1984 amendments to the Resource Conservation and Recovery Act (RCRA) required the US EPA to develop new federal regulations for reducing and controlling environmental damage from underground storage tank leakage by 1987. In addition, many states and localities have developed and are implementing strict regulations governing underground storage tanks and remedial action for releases from tanks to soil and groundwater. The results of a jointly funded study by the Electric Power Research Institute (EPRI) and the Utility Solid Waste Activities Group (USWAG) are summarized. Available technologies for remediating soil and groundwater containing petroleum products released from an underground storage tank leak or other discharges, leaks, or spills and are estimated. The remedial technologies were divided into two categories: in situ treatment and non-in situ treatment. The remedial technologies were further subdivided within these categories as follows: In situ technologies--volatilization, biodegradation, leaching and chemical reaction, vitrification, passive remediation, isolation/containment; and Non-in situ technologies--land treatment, thermal treatment, asphalt incorporation, solidification/stabilization, groundwater extraction and treatment, chemical extraction, and excavation. The most viable option will depend on the site-specific conditions involved. Costs, risk factors, exposure pathways, and type and quantity of leak are some of the factors that need to be considered in selecting the most appropriate remedial action. (See also W90-03830) (Lantz-PTT)
W90-03839

EVALUATION OF ORGANIC MATERIALS THAT INTERFERE WITH STABILIZATION/SOLIDIFICATION PROCESSES.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
M. J. Cullinane, and R. M. Bricka.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 127-136, 7 fig, 1 tab, 12 ref.

Descriptors: *Land disposal, *Concrete, *Waste disposal, *Organic compounds, *Oil pollution, *Waste stabilization, Solidification, Phenols, Trichloroethylene, Hexachlorobenzene, Grease, Portland cements, Fly ash, Lime.

The US EPA is responsible for evaluating the suitability of hazardous waste and materials for land disposal. Chemical stabilization/solidification (S/S) is one technique that has been proposed as a method for controlling the release of contaminants from landfilled wastes to surface and groundwaters. A variety of S/S technologies have been proposed for treating hazardous wastes. The most commonly applied technologies use portland cement, pozzolan, or portland cement-pozzolan combinations as the primary means of contaminant immobilization. A potential problem with using S/S technology involves chemical interferences with the hydration reactions typical of the portland cement and pozzolan processes. Of particular concern to S/S technology is the effect of organic compounds on the strength and contaminant immobilization characteristics of the final product. Data on the compatibility of organic waste constituents with three binding agents: portland cement, portland cement/fly ash, and lime/fly ash were obtained. Oil, grease, trichloroethylene, hexachlorobenzene, and phenol were then tested for interference with the three binding agents. Several conclusions can be drawn that characterize the effects of the interference materials investigated in this project on the unconfined compressive strength (UCS) of stabilized/solidified waste materials. The interference chemicals tested had a measurable effect on the setting and strength development properties of the stabilized/solidified waste. Stabilized/solidified waste showed decreased UCS development with increasing oil or grease concentrations. Although the waste stabilized with portland cement resulted in lower 28-day strength development, it appears that the concentration of interference material had less effect on the UCS development properties for the portland cement binder than for the portland cement/fly ash or lime/fly ash binders. Phenol concentrations > 5% resulted in marked decreases in 28-day UCS development for all the binders tested. The chlorinated hydrocarbons evaluated in this study had less effect on the UCS development properties than the other interference materials investigated. (See also W90-03830) (Lantz-PTT)
W90-03840

IN SITU VITRIFICATION PROCESSING OF SOILS CONTAMINATED WITH HAZARDOUS WASTES.
Battelle Pacific Northwest Labs., Richland, WA.
C. L. Timmerman, J. L. Buelt, and V. F. FitzPatrick.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 137-156, 10 fig, 2 tab, 11 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Soil contamination, *Hazardous wastes, *Cleanup operations, Economic aspects, In situ treatment, Organic compounds, Waste treatment, On-site wastewater treatment.

In situ vitrification (ISV) is a thermal treatment process that converts contaminated soil into a chemically inert and stable glass and crystalline product. The ISV process is demonstrated at field-scale conditions, eliminating uncertainties of scale-up. The applicability of the ISV process to a particular waste can be determined with existing ISV equipment for a few thousand dollars. Thus, feasibility testing is relatively inexpensive. Experience to date indicates that the process is ready for deployment for soil sites contaminated with heavy metals and inorganics. Experience with low boiling point organics that are uncontaminated in the soil column is very limited, and feasibility testing with actual site samples prior to application is strongly recommended. The experience with PCBs, process sludges, and plating wastes is very encouraging. It is anticipated that the ISV process will be used for a broader application of waste management problems. It is also recognized that no single treatment process is applicable to all waste management needs. Specific benefits inherent in the ISV process are: safety for workers and public; long-term durability of the waste form (> 1 million yr); applicability to a variety of soils; cost-effectiveness ($100-$250/ton for soils); volume reduction for sludges (< $100/ton); and efficient processing rates (3-5 tons/hr). In summary, the ISV process is cost-effective, applicable to a wide variety of soils and wastes, and responsive to the regulatory changes that emphasize the need for onsite treatment and remediation. (See also W90-03830) (Lantz-PTT)
W90-03841

FIELD STUDIES OF IN SITU SOIL WASHING.
Weston (Roy F.), Inc., West Chester, PA.
J. H. Nash, and R. P. Traver.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 157-162, 1 fig, 1 tab.

Descriptors: *Chemical treatment, *Cleanup operations, *Soil contamination, *Soil washing, Water pollution treatment, Surfactants, Groundwater quality, Lime, Air stripping, Organic carbon, Wisconsin.

Part of the US EPA's Superfund site cleanup research has been directed at washing contaminated soil with the aid of aqueous surfactant solutions. The research takes two directions. The first is to excavate the soil and mix it in a wash solution. The second research objective concentrates on the application or injection of a surfactant solution into undisturbed soil in situ. The US Air Force, as part of its Installation Restoration Program, was seeking processes to clean up 128 fire training pits at Air Force installations. The Air Force selected the Air National Guard base in Camp Douglas, Wisconsin as a candidate site for the EPA to test either excavated or in situ soil washing. Previous laboratory work identified a 50:50 blend of two commercially available surfactants that work well in removing contaminants from soil (Adsee 799 and Hyonic PE-90). To determine if this same blend would work at the Volk Field fire training pit, contaminated soil samples were collected. In situ soil washing of the Volk Field fire training pit with aqueous surfactant solutions was not measurably effective. It is likely that this same ineffectiveness would occur at other chronic spill sites that have contaminants with high soil-sorption values. In situ soil washing requires groundwater treatment. Groundwater treatment at this site was very successful with the simple addition of lime while air stripping effectively removed the volatile organics. Advantages at this site were its remoteness for workable air emission limits that facilitated groundwater treatment operations and a local sewage treatment system owned by the responsible party. Total organic carbon levels of the recovered groundwater were reduced to one-half the initial values by precipitation with lime, which allowed for direct discharge to the aerobic treatment lagoons. Obviously, not all waste sites have these favorable conditions. (See also W90-03830) (Lantz-PTT)
W90-03842

LAND TREATMENT OF HYDROCARBON CONTAMINATED SOILS.
Remediation Technologies, Inc., Concord, MA.
J. Lynch, and B. R. Genes.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 163-174, 5 fig, 4 tab.

Descriptors: *Cleanup operations, *Land disposal, *Oil pollution, *Soil contamination, Creosote, Economic aspects, Organic compounds, Benzene, Hydrocarbons.

Land treatment has been used as a waste treatment and disposal technology by U.S. petroleum refineries for more than 25 years. Land treatment uses the assimilative capacity of the soil to decompose and contain the applied waste in the surface soil layer (usually the top 15-30 cm or 6-12 in). The upper soil layer is the zone of incorporation (ZOI). The incorporation zone, in conjunction with the underlying soils where additional treatment and immobilization of the applied waste constituents occur, is referred to as the treatment zone. The treatment zone in the soil may be as much as 1.5 m or 5 ft. Soil conditions below this depth generally are not conducive to oxidation of the applied waste constituents. The transformations, biological oxidations, and immobilization will occur primarily in the zone of incorporation. In this study three different loading rates were evaluated in test plot studies: 2%, 5%, and 10% benzene extractable (BE) hydrocarbons. The soils used in the pilot study consisted of a fine sand which was collected from the upper 2 ft of the Resource Conservation and Recovery Act (RCRA) impoundment. The soil was contaminated with creosote constituents consisting primarily of polynuclear aromatic (PNA) compounds. Total PNAs in the soil ranged from 100 to 10,000 parts per million (ppm), and BE hydrocarbons in the contaminated soil ranged from approximately 2% to 10% by weight. The data collected during this study shows that onsite treatment of creosote contaminated soils is feasible. Based on the data developed in pilot-scale studies, a conservative design for a full-scale system was developed and constructed. The full-scale unit has matched or surpassed the performance of the pilot-scale unit in degrading creosote organics. The advantages of onsite treatment are that it reduces the source of contaminants at the site in a very cost-effective manner. In addition, it satisfies the developing philosophical approach that EPA has to onsite remedies, and it reduces the liability of the owner/operator due to offsite disposal. (See also W90-03830) (Lantz-PTT)
W90-03843

LOW TEMPERATURE STRIPPING OF VOLATILE COMPOUNDS.
Weston (Roy F.), Inc., West Chester, PA.
L. A. Velazquez, and J. W. Noland.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 201-209, 3 fig, 1 tab, 1 ref.

Descriptors: *Cleanup operations, *Thermal stripping, *Volatile organic compounds, *Soil contamination, Oil pollution, Temperature, Vaporization.

Contamination of soils from past operations involving volatile organic compounds (VOCs), such as leaking underground fuel storage tanks, has become a major environmental concern. Low temperature thermal stripping of the VOCs from the soil was found to be an efficient method for removal of these contaminants. Further work in the field of low temperature thermal treatment (LT) has resulted in the design of an innovative low temperature process, LT super 3. The LT super 3 process is a demonstrated technology that provides evaporation of the VOCs, but does not require heating the soil matrix to combustion temperatures. The heart of the technology is the thermal processor, an indirect heat exchanger (utilizing hot screws), that is used to dry and heat the contaminated soils up to 450 F, consequently stripping the VOCs from the soil. The indirect heating of the soil minimizes gas flows and reduces the size of the offgas handling equipment. Once the organic contaminants are vaporized, they can either be destroyed through high temperature incineration in an afterburner, or recovered through condensation or adsorption on activated carbon. Some of the advantages of the LT super 3 process are: lower capital and operating costs than incineration; process is considerably smaller and more mobile than an incinerator with the same throughput; process can be used for product recovery, which is not possible for incineration; process results in a processed soil that is suitable for onsite backfill. This eliminates the long-term liability of landfill disposal or onsite containment or storage; low temperature minimizes the chance of hazardous heavy metal emissions; and the process can be designed to be compact and fully mobile (i.e., fully mounted on three flatbed trailers). (See also W90-03830) (Lantz-PTT)
W90-03844

RECOVERY TECHNIQUES AND TREATMENT TECHNOLOGIES FOR PETROLEUM AND PETROLEUM PRODUCTS IN SOIL AND GROUNDWATER.
Dragun Corp., Berkley, MI.
J. Dragun.
IN: Petroleum Contaminated Soils. Volume I: Remediation Techniques, Environmental Fate, Risk Assessment. Lewis Publishers, Inc., Chelsea, Michigan. 1989. p 211-217, 13 ref.

Descriptors: *Cleanup operations, *Oil pollution, *Soil contamination, *Groundwater pollution, In situ treatment, Biodegradation, Land disposal, Composting, Vitrification.

Petroleum and its products can exist in soil in several forms including residual saturation, free-floating petroleum, dissolved petroleum, and vapor phase petroleum. There are two in situ techniques--soil venting and in situ flushing--and one technique using excavated soil--low temperature stripping--that can be utilized to partially or totally recover residual petroleum and its products from soil. There are several treatment technologies that can be utilized for soil with residual saturation, free-floating petroleum and its products, and dense petroleum products. These include natural degradation, land treatment, composting, incorporation into binding agents and fixatives, vitrification, and in situ biodegradation. In situ recovery technologies for free-floating petroleum and petroleum products include interceptor trenches and recovery wells. The primary in situ recovery technology for dense petroleum product is the recovery well. The most extensively applied recovery techniques for dissolved petroleum and its products involve the extraction of groundwater by pumping or gravity flow into drains and trenches. Treatment usually involves traditional unit processes. (See also W90-03830) (Lantz-PTT)
W90-03845

INTERFACING NONPOINT SOURCE PROGRAMS WITH THE CONSERVATION RESERVE: GUIDANCE FOR WATER QUALITY MANAGERS.
North Carolina State Univ. at Raleigh.
M. D. Smolen, K. J. Adler, A. L. Lanier, D. L. Hoag, and D. W. Miller.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134126. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA 506/2-88/001, September 1988. 24p, 3 fig, 2 tab, 22 ref. EPA Contract CR813753-01-0.

Descriptors: *Regulations, *Water quality management, *Nonpoint pollution sources, *Water pollution prevention, *Management planning, Water Quality Act, Handbooks, Conservation, Wetlands, Land management.

EPA is supporting state implementation of Section 319 of the 1987 Water Quality Act with a combination of the nonpoint source (NPS) Guidance Manual, the State Clean Water Strategy, Setting Priorities: The Key to NPS Pollution Control, and a variety of other technical guides (such as this one) and grant mechanisms. These support documents stress the importance of targeting NPS-program resources and coordinating with other federal and state efforts. The manual is intended as a guide for state NPS agencies and area-wide planning agencies to coordinate Section 319 activities with Food Security Act of 1985 (FSA85) Title XII--Conservation, which created the Conservation Reserve, Highly Erodible Land Conservation (HELC), and Wetland Conservation (WC) subtitles. The HELC subtitle mandates the Conservation Compliance (CC) and Sodbuster programs that protect highly erodible cropland. In addition, to discourage drainage of wetlands, the Swampbuster program was established, under the WC subtitle. The manual uses targeting concepts, reviews FSA85 conservation programs, with an emphasis on the Conservation Reserve Program (CRP), and suggests ways to coordinate programs to optimize the state's NPS management effort. (Lantz-PTT)
W90-03848

EFFECTS OF HIGHWAY RUNOFF ON WATER QUALITY OF TWO WETLANDS IN CENTRAL FLORIDA.
Geological Survey, Orlando, FL. Water Resources Div.
D. M. Schiffer.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4200, 1989. Project no. FL-416. 63p, 32 fig, 9 tab, 37 ref.

Descriptors: *Water pollution sources, *Water pollution control, *Highway effects, *Wetlands, *Water quality, *Florida, Heavy metals, Bottom sediments.

Results of a study of the effects of highway runoff on the chemical quality of water and bed sediments of a cypress wetlands and a freshwater marsh in central Florida indicate that detention of the runoff prior to release into the wetland reduces concen-

trations of automobile-related chemicals in the water and bed sediments in the wetland. Detention of highway runoff for the cypress wetland occurs in a 68-ft by 139-ft detention pond, and in a 12-ft by 25 ft trash retainer for the freshwater marsh. The analysis of the chemical data for water and bed sediments indicates that many of the observed differences in chemistry are due to the difference in detention facilities. Water quality generally improved from the inlet to the outlet of both wetlands. Only inlet and outlet data were collected at the cypress wetland, and these showed a reduction in concentrations through the wetland. Spatial data collected at the freshwater marsh indicated that constituent concentrations in water generally decreased with distance from the inlet. Results of analysis of variance of grouped data for 40 water quality variables at the freshwater marsh inferred that 26 of the 40 variables tested were significantly different among five general locations within the wetland: inlet, outlet, near, intermediate, and far sites (with respect to the inlet). Results from this study indicate that detention structures, larger than the trash retainer at the freshwater marsh, may cause sufficient sorption and settling of substances contained in highway runoff to minimize the transport and deposition of some undesirable chemicals into wetlands. (USGS)
W90-03874

GEOHYDROLOGY OF THE ESCONDIDO HYDROLOGIC SUBAREA, SAN DIEGO COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03882

EFFECT OF NUTRIENTS AND PESTICIDES APPLIED TO TURF ON THE QUALITY OF RUNOFF AND PERCOLATING WATER.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
T. L. Watschke, and R. O. Mumma.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-236756/AS, price codes: A04 in paper copy, A01 in microfiche. Report ER8904, 1989. 64p, 15 fig, 12 tab, 16 ref, 4 append. USGS Contract no. 14-08-0001-G1293.

Descriptors: *Water quality control, *Water sources, *Water spreading, *Water storage, *Water treatment, *Turf grasses, *Runoff, *Percolation, Water quality, Surface runoff, Watersheds, Infiltration, Groundwater, Pesticide removal, Leaching, Leachates, Nutrients.

The objective of this investigation was to determine the effect that nutrients and pesticides applied to lawn-type turf had on the quality of runoff and leachate. The results indicate that dense, high quality turfgrass stands, regardless of establishment method, affect the overland flow process to such a degree that runoff is insignificant. The ability of this type of vegetative community to allow water to infiltrate and promote the metabolism of solutes suggest that it might even possess the ability to be used as a water quality treatment medium. Levels of management required to produce the turf quality necessary for positive water quality impacts have not been determined. It is assumed that many poor quality turfgrass areas are not recipients of sound professional management. While these sites may not exhibit the infiltration capacity of high quality turf, nutrients and pesticides are also much less likely to have been used on them. Finally, much of the highly managed turfgrass in the United States is maintained in regions of varying degrees of urbanization. Considering the magnitude of runoff contributed by impervious surfaces and the fact that treated turfgrass acres in those watersheds constitute only a portion of the previous fraction of the landscape, dilution of any low-level 'spikes' of nutrients and/or pesticides would certainly occur. Acceptable background levels of these materials in surface water have not been determined. It is likely that their concentrations in storm water and impact on receiving bodies of water would be considerably less than other urban pollutants not associated with well-managed turfgrass areas. (McDonnell-Penn. St U.)
W90-03894

MUNICIPAL SOLID WASTE MANAGEMENT IN GEORGIA, POLICY ALTERNATIVES.
Georgia Univ., Athens. Carl Vinson Inst. of Government.
J. E. Kundell.
Available from Publication Program, Carl Vinson Institute of Government, University of Georgia. Public Policy Research Series, (June 1989). 23p, 7 tab, 59 ref.

Descriptors: *Solid waste disposal, *Environmental quality, *Waste disposal, *Georgia, *Waste management, Garbage dumps, Waste dumps, Municipal solid waste, Waste recovery, Environmental policy.

Increasingly, the proper management of municipal solid waste (garbage) is becoming a controversial responsibility facing state and local officials. It is projected that by the year 2000, the United States will produce over 190 million tons of municipal solid waste annually. Georgia's share of this may exceed 6 million tons. This report reviews the current status of solid waste management in Georgia and nationally, and examines various policy options which would enable municipal solid wastes to be managed more efficiently in one state. Underlying the specific policy alternatives discussed, however, are the needs for adequate funding and effective planning on the part of state, regional, and local governments. Adopting an integrated waste management system is recommended. (Allen-Carol Vinson Inst.)
W90-03895

GROUNDWATER POLLUTION LITIGATION IN THE FEDERAL COURTS: AN EVALUATION OF THREE NEW PRIVATE REMEDIES.
Office of the Associate Attorney General, Washington, DC. Land and Natural Resources Div.
D. C. Shilton.
Journal of Environmental Law and Litigation, Vol. 3, p 91-129, 1988.

Descriptors: *Groundwater pollution, *Administrative regulations, *Legal aspects, *Water law, *Environmental policy, *Resource Conservation and Recovery Act, Groundwater, Federal jurisdiction, Water pollution, Remedies.

Several recent lawsuits involving groundwater pollution have invoked one or more federal causes action, sometimes in combination with pendent state common law claims. Only a few of these suits have been decided on the merits, and cost of the reported decisions focus on threshold issues. However, it is possible to draw some tentative conclusions about the effectiveness of these new causes of action. The elements of these causes of action are reviewed, some pitfalls are identified that should be avoided, and the role that these actions may play in addressing the groundwater pollution problem are evaluated. With one of the element of cause of action, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the actions must respond to the release of a hazardous substance from a facility, and the recovery is limited to necessary costs of response. Cost must be incurred prior to bringing suit and must be consistent with the National Contingency Plan. CERCLA requires only a weak showing of causation. Under the Resource Conservation and Recovery Act (RCRA), the plaintiff must allege an ongoing violation, and a citizen cannot bring suit under RCRA until 60 days after giving notice fo the alleged violation to the EPA. While an award of damages cannot be made under RCRA, the act authorizes the court to award costs of litigation. Because RCRA invokes the full equitable powers of a court, a citizen suit can lead to adoption of a judicially supervised plan that brings a disposal facility into compliance with groundwater protection requirements. With the 1984 amendments to RCRA allowing citizen suits to Abate Imminent Hazards, a citizen is allowed to sue a past generator or transporter of waste currently posing a threat to the environment, or a past owner of a leaky dump site. These amendments address groundwater pollution problems stemming from inactive as well as active waste disposal sites. It is concluded that the preventive orientation of these laws mean that Congress has thus far left victims of toxic wastes to rely on tort remedies, with all their limitations. (Friedmann-PTT)
W90-03898

LONG-TERM EFFECTIVENESS OF VEGETATIVE FILTER STRIPS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
T. A. Dillaha, J. H. Sherrard, and D. Lee.
Water Environment and Technology, Vol. 1, No. 3, p 419-421, November 1989.

Descriptors: *Virginia, *Nonpoint pollution sources, *Filter crops, *Water pollution control, Vegetative filter strips, Long-term studies, Performance evaluation, Surveys, Grasses, Forages, Erosion control, Soil conservation, Nutrient control, Cost sharing.

One method of removing sediment and nutrients from agricultural runoff is vegetative filter strips (VFS). VFS of varying ages in rural Virginia were studied to assess their effectiveness. The VFS were visited five times at 3-mo intervals between March 1985 and April 1986. Opinions of owners of VFS were obtained by a mail survey. Of 33 farms visited and evaluated, 18% had no VFS and 18% of the existing VFS were simply pastureland borders. By the end of the project, 50% of the VFS had good to excellent cover, 14% had fair cover, and 27% had poor cover. Tall fescue was the dominant vegetation in all but two of the VFS, but orchard grass, clover, and lespedeza also were present. To increase the cost-effectiveness of VFS with respect to water quality, the following specifications and recommendations should be incorporated into VFS cost-sharing programs: VFS site suitability should be determined by trained personnel; vegetation and seeding rates should be appropriate for local soil and climatic conditions, and approved for use in the designated area; to promote good vegetative growth, nutrient removal, and filtering ability, VFS should be mowed and the residue harvested at least 2-3 times per year; and before payment of cost-sharing funds is approved, and once each year thereafter, the VFS should be inspected by a conservation or pollution control official to ensure that the VFS meets minimum standards. (Rochester-PTT)
W90-03956

WATER QUALITY 2000: BUILDING A NATIONAL CONSENSUS.
A. B. Nichols.
Water Environment and Technology, Vol. 1, No. 3, p 422-425, November 1989.

Descriptors: *Water quality, *Water Quality 2000, *Public participation, *Public relations, Water Pollution Control Federation, Decision making, Policy making, Management planning.

Water Quality 2000, a program born in 1987 within a subcommittee of the Water Pollution Control Federation's Government Affairs Committee, has the mission of 'proposing and promoting national policies and goals for the 21st century that will protect and enhance water quality, with a specific agenda for action.' The history of the project, its structure and organization, the principle of balancing views, and the keys to the project's success are described. Water Quality 2000 is structured in four phases: (1) plan development and goal setting (July 1988-May 1989); (2) definition of problems and present water quality policies and programs (May 1989-May 1990); (3) development of recommendations for action (May 1990-May 1991); and (4) implementation (May 1991-May 1992). The project is guided by a vision of society living in harmony with healthy natural systems. All phases of the water cycle, including groundwater, surface water, and atmospheric water, are considered. Strategies to be promoted include source reduction and waste minimization and water conservation and reuse. The Water Quality 2000 project Phase 2 work groups cover the following topics: agriculture, aquatic ecosystems and habitat, community,

energy and resource extraction, industrial, legislation, recreation, transportation, watershed, and water supply. (Rochester-PTT)
W90-03957

MAKING THE STATE REVOLVING FUND WORK: THE TENNESSEE EXPERIENCE.
Tennessee Dept. of Health and Environment, Nashville.
For primary bibliographic entry see Field 6C.
W90-03958

PRETREATMENT FOR RAW WATER STORAGE.
Water Storage Corp., Werkendam (Netherlands).
For primary bibliographic entry see Field 5F.
W90-03959

EXPERIENCES OF QUALITY CONTROL OF RAW WATER STORAGE RESERVOIRS.
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
J. Clasen, and H. Bernhardt.
Aqua AQUAAA, Vol. 38, No. 4, p 256-264, August 1989. 15 fig, 1 tab, 14 ref.

Descriptors: *Network design, *Reservoirs, *West Germany, *Raw water, *Water storage, *Water quality control, *Sampling, Wahnbach Reservoir, Intakes, Hypolimnion, Aeration, Mixing, Destratification, Spatial variation, Temporal variation.

Based on 30 yr of operating the Wahnbach Reservoir (West Germany) as a raw water storage reservoir, the fundamental approach to a reservoir investigation program is discussed. Objectives of the program include horizontal allocation of sampling points, vertical allocation of sampling points, selection of parameters for measurement, and frequency of sampling. The program must be designed so that, with minimal effort, maximal information about spatial and temporal changes of the physical, chemical, and biological quality parameters can be obtained. The results of the investigation program are used to select the most favorable raw water intake depth and to work out protecting measures at the tributaries and the reservoir itself. Operating a hypolimnic aeration program has a profound effect on the water quality parameters of the reservoir. It is possible to detect long-term changes in both reservoir conditions and the quality of the impounded water and to observe the effects of protective measures. (Rochester-PTT)
W90-03968

FOOD-WEB MANIPULATION AS A TOOL IN WATER-QUALITY MANAGEMENT.
Technische Univ., Dresden (German D.R.). Sektion Wasserwesen.
J. Benndorf.
Aqua AQUAAA, Vol. 38, No. 5, p 296-304, October 1989. 3 fig, 1 tab, 62 ref.

Descriptors: *Food chains, *Water quality control, *Reservoirs, Lakes, Feedback mechanisms, Nutrients, Light, Fish management, Biomass, Biomanipulation, Ecology.

Water quality depends largely on the structure and function of food webs in aquatic ecosystems. Food webs can be controlled by resource limitation ('bottom up') and by predation ('top down'). It has been widely accepted that both control mechanisms are closely coupled. For this reason, top-down control of the food web by manipulating fish stocks should be applied with caution as the sole management tool. Long-term stability of top-down control depends on numerous factors (lake-specific characteristics, indirect effects, time lag, feedback dynamics, coupling of different types of food webs) and it seems to increase with increasing resource limitation (nutrients, light). Therefore, combined bottom-up/top-down control appears to be the most promising strategy in water quality management. At present, the short-term effects of food-web manipulation can be predicted with a certain degree of reliability, but the predictability of long-term effects is rather low. Important points are as follows: (1) food-web manipulation should be combined with a resource-limitation measure if the biomanipulation-efficiency threshold is exceeded; (2) the critical biomass of undesirable fish, below which effects on the food web and water quality can be observed, varies greatly (20-1000 kg/ha) and depends on numerous factors; (3) the maximum possible stability of food-web manipulation probably is achieved when the biomass of undesirable fish is a little below the critical biomass rather than when fish are completely exterminated; (4) management should aim at a high diversity of piscivorous fish stocks (species, age classes); (5) time lags exist when piscivory is used and this effect must be taken into account in management; (6) various techniques of food-web manipulation should be combined (excluding poisoning); and (7) food-web manipulation should be combined with a reasonable protection of the ecosystem against toxic pollutants because key species (eg, Daphnia, Fucus) are extremely sensitive. (Rochester-PTT)
W90-03971

DECISION SUPPORT FOR ESTUARINE WATER QUALITY MANAGEMENT.
California Univ., Davis. Dept. of Civil Engineering.
U. Arnold, and G. T. Orlob.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 775-792, November 1989. 15 fig, 14 ref.

Descriptors: *California, *Computer programs, *Estuaries, *Water quality control, Management planning, Newport Bay, Pollution load, Decision making, Mathematical models, Hydrologic models, Simulation, Graphics.

Management of water quality in estuarine systems is a multistepped process, ranging from characterization of hydrological and hydromechanical properties that govern water quality changes through identification of waste loads, regulatory constraints, and water quality attributes to identification of alternative candidate plans and selection by so-called decision makers of the best plan to be implemented. The ultimate step in this complex process is to operate the physical system within the stipulated performance goals. With the advent of ever-increasing computer power, geographic information systems, and interactive graphics, supporting integrated user-friendly data management and processing, have been added to the body of tools intended to support the decision process through its many steps. The use of a new-generation microcomputer, the Macintosh II, as the sole host for a decision support system is described and how this system might be used in the decision making process is illustrated with the example of Newport Bay, Orange County, California. Special attention is given to such features as: (1) object-oriented data and control handling; (2) the integration of simulation models into the decision support system; and (3) the water quality management process. Graphical displays facilitate the construction of models, assignment of attributes, location of treatment plants, fixing of levels and costs of treatment, and direct interactive inspection of the results of simulations. Displays of water quality responses to alternative management scenarios allow the user to judge the merits of adjustments in treatment efficiency, outfall location, and other physical and operational changes in the system. (Rochester-PTT)
W90-03978

RECONCILING PUBLIC OPINION AND WATER QUALITY CRITERIA IN SOUTH AFRICA.
Cape Town City Council (South Africa). City Planner's Dept.
J. A. Thornton, and P. H. McMillan.
Water SA WASADV, Vol. 15, No. 4, p 221-226, October 1989. 4 tab, 37 ref.

Descriptors: *Water quality, *South Africa, *Public opinion, *Lakes, Cape Town, Pretoria, Limnology, Management planning, Public participation.

A definition of a 'clean water lake' was compiled from the responses to an open-ended question to give a definition of such a lake by over 3,000 recreational users of inland waters in the greater Pretoria and Cape Town areas (South Africa). Visually aesthetic characteristics were the most commonly cited means of determining the pollution status of a lake. These included: the absence of scum and excessive quantities of algae, clear water with low turbidity, and an abundance of wildlife. These characteristics were equated to common limnological variables such as chlorophyll a and Secchi disc transparency and a scale of values acceptable to the public was created by reference to the survey and to the literature where necessary. These values corresponded to values used by water management authorities and limnologists to define lake trophic state. (Author's abstract)
W90-03990

USE OF AQUATIC MACROPHYTES IN WATER-POLLUTION CONTROL.
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5D.
W90-04003

RECLAMATION OF SALINE SOILS USING CALCIUM SULFATE RESIDUES FROM THE TITANIUM INDUSTRY.
Centre de Recherches de Colmar (France).
M. Kayasseh, and C. Schenck.
AMBIO AMBOCX, Vol. 18, No. 2, p 124-127, 1989. 6 tab, 23 ref.

Descriptors: *Soil management, *Saline soils, *Calcium sulfate, *Soil reclamation, *Sludge utilization, *Land reclamation, Chemical treatment, Chemical sludge, Chemical wastes, France.

An attempt at desalination has been performed on two kinds of soils containing different levels of sodium chloride contamination. The study was carried out in upper-Alsace, France, from 1980 to 1982. Contamination was caused by sylvinite extraction and by the potash industry. The two alluvial soils that were analyzed contained sodium concentrates of 42 and 418 meq/kg. The threshold limit level for plant growth is 30 meq/ha. Plaster and titanium-industry residues with high CaSO4 contents were used as reclamation agents. Effects were compared with those obtained with natural precipitation and flood water. The results of the study suggest that the use of industrial residue as well as plaster is efficient for reclamation of fairly saline soils. The amount of residue needed is about 3 to 7 tons per ha, which is comparable to additions of 7 tons of plaster per ha. (Author's abstract)
W90-04005

EXPERIENCES WITH GROUNDWATER TREATMENT AND DISPOSAL OF THE ELIMINATED SUBSTANCES IN THE NETHERLANDS.
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 5F.
W90-04018

DESIGN OF A HYDRODYNAMIC LEACHATE CONTAINMENT SYSTEM.
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-04019

PCB-POLLUTION PROBLEM IN THE UPPER HUDSON RIVER: FROM ENVIRONMENTAL DISASTER TO 'ENVIRONMENTAL GRIDLOCK'.
Barnard Coll., New York. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-04026

ENHANCED RETENTION OF ORGANIC CONTAMINANTS BY SOILS EXCHANGED WITH ORGANIC CATIONS.
Michigan State Univ., East Lansing. Dept. of Communication.

For primary bibliographic entry see Field 5B.
W90-04047

BIODEGRADATION OF CRUDE OIL IN AN EXPERIMENTALLY POLLUTED PEATY MANGROVE SOIL.
Institut de la Carte Internationale du Tapis Vegetal, Toulouse (France).
P. Scherrer, and G. Mille.
Marine Pollution Bulletin MPNBAZ, Vol. 20, No. 9, p 430-432, September 1989. 1 fig, 1 tab, 5 ref.

Descriptors: *Water pollution treatment, *Biodegradation, *Fate of pollutants, *Oil pollution, *Soil contamination, *Mangrove swamps, *Microbial degradation, Organic matter, Nutrients, Fertilizers, Oxygen.

The role of environmental factors on oil biodegradation was studied in an experimental peaty mangrove soil (60% peat, 40% clay) on Guadeloupe. Two plots (2 sq m ea) were polluted with 5 L oil/sq m. One plot received crude oil, the other oil premixed with 10% bioactivator (an oleophilic fertilizer). Samples were collected at each plot after 3 days, 3 months, and 11 months. The top 30 cm of soil were contaminated with decreasing concentrations from top to bottom. Addition of bioactivator to the oil favored its accumulation at the soil surface. At 3 and 11 months, the plot with the bioactivator showed normal alkane biodegradation while the degradation of oil without bioactivator was extremely limited. The results suggest that an oil polluted mangrove is likely to remain polluted for a long time. Oil metabolism, which is the main degradation pathway for crude oil in soil, was limited by the availability of oxygen and nutrients in the peat. Oleophilic fertilizers might be used to enhance biodegradation in a nutrient deficient environment. The toxicity of such products to the fauna and flora of the area should be tested before the use of the bioactivators in mangrove. (Geiger-PTT)
W90-04058

ENVIRONMENTAL QUALITY OBJECTIVES AND EFFLUENT CONTROL.
Water Research Centre, Medmenham (England).
R. Agg, and T. Zabel.
Chemistry and Industry CHINAG, No. 14, p 443-447, July 17, 1989. 2 fig, 1 tab, 24 ref.

Descriptors: *Regulations, *Water pollution control, *Water quality standards, *Legal aspects, *Europe, *North Sea, European Community Substances Directive, Toxicity.

The European Community Substances directive provides legislation to control the discharge of toxic substances to the aquatic environment. Additional directives are necessary, however, to set the environmental quality standards and limit values for individual substances. The Directive has two lists of compounds: List I contains substances regarded as particularly dangerous because of their toxicity, persistence and bioaccumulation, while List II consists of less dangerous compounds that can have a deleterious effect on the aquatic environment. List I compounds are mandated to be eliminated, whereas pollution by List II substances must be reduced. In the ministerial declaration following the second ministerial conference on the Protection of the North Sea held in November 1987, the United Kingdom agreed to apply the dual approach to the control of certain dangerous substances. Recommendations included: identification of a limited range of the most dangerous substances--the 'Red List;' setting of strict environmental quality standards for all Red List substances; and progressive application of emission standards based on the concept of best available technology, not entailing excessive costs for the control of direct discharges of Red List substances. Two approaches at controlling pollution were explored. The environmental quality objective approach is based on the premise that a minimum acceptable concentration of a pollutant can be defined that does not interfere with the use of the water it has polluted. Setting of environmental quality standard values relies heavily on knowledge of bioaccumulation and toxicity effects. This information is often incomplete and depends on interpretation. These standards are set by the Water Research Center in the United Kingdom, which reviews the available laboratory and field toxicity data, and prepare a report proposing environmental quality standards for the different uses where appropriate. Experts from the Department of the Environment, the Ministry of Agriculture, Fisheries and Food and the water industry also review the report. (Mertz-PTT)
W90-04092

BIORESTORATION OF CONTAMINATED SOIL AND GROUNDWATER.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. of Waste Materials and Emissions.
S. Staps.
Chemistry and Industry CHINAG, No. 18, p 581-584, September 18, 1989. 1 fig, 3 tab, 7 ref.

Descriptors: *Cleanup operations, *Water pollution treatment, *In situ treatment, *Biological treatment, *The Netherlands, *Groundwater pollution, Land-farming, Bioremediation.

In the Netherlands, soil clean-up operations have been undertaken for the past eight years. Initially, on and off-site thermal and extraction techniques were developed. In the last five years, there has been a growing interest in biological techniques. Of these techniques, land-farming is in operation in the Netherlands and experiments in bioreactors are underway. The advantage of in situ clean-up techniques is that they can be applied without excavation of the soil. Depending on the contaminants present, physical/chemical or biological processes can be used for remediation. In situ biorestoration is based on the stimulation of the natural degradation processes in the soil. Conditions for applications include: a high soil permeability, biologically degradable contaminants, and a site that can be converted into an environment where biodegradation is possible. There are many advantages to in situ biorestoration. It is often applicable when other techniques cannot be employed (for instance, when excavation is not possible), it is possible to treat both soil and groundwater. Biorestoration is environmentally sound and generally cost-effective. Treatment is also able to move with the plume of contamination in the groundwater. There are such disadvantages as the following: (1) It can only be applied to biodegradable components; (2) it may not work for subsoils with low permeabilities; and (3) it may be inhibited by toxic components and soil can become clogged by excessive bacterial growth. A long treatment period, the possibility of residual concentrations remaining in the soil and a lack of knowledge about long term effects still hinder biorestoration. (Mertz-PTT)
W90-04094

WATER SUPPLY AND SANITATION: AN AGENDA FOR RESEARCH.
London School of Hygiene and Tropical Medicine (England).
For primary bibliographic entry see Field 5F.
W90-04110

EXPERT OPINION AND GROUND-WATER QUALITY PROTECTION: THE CASE OF NITRATE IN DRINKING WATER.
Iowa Univ., Iowa City. Dept. of Geography.
R. Rajagopal, and G. Tobin.
Groundwater GRWAAP, Vol. 27, No. 6, p 835-847, November-December 1989. 1 fig, 3 tab, 28 ref.

Descriptors: *Drinking water, *Nitrates, *Groundwater pollution, *Water pollution prevention, Management planning, Surveys, Environmental policy.

Groundwater protection strategies have been constrained by the limited consideration of varied and new options relevant to particular problems. Consequently, management practices have tended to maintain the status quo regarding legislation and water-quality standards. To examine the responses to specific issues, an analysis of the problem of nitrate contamination of groundwater in the Midwest to a community of experts was conducted. Ninety-seven individuals, through a formal questionnaire, responded to a variety of questions pertaining to the issue. They showed definite preferences in dealing with certain aspects of the problem, although there was significant variability in response due to such factors as length of groundwater-related professional experience and residential status. It was clear that respondents preferred immediate preventive or corrective action in a world of incomplete knowledge over extensive research; were willing to undertake personal action to seek nitrate-free water rather than wait for official action; and favored local and state level involvement over federal intervention. Findings based on this survey research can be used effectively in the planning of future work to establish actual preferences in communities with serious nitrate contamination problems. (Author's abstract)
W90-04162

DETERMINATION OF AN OPTIMAL POLICY FOR PROTECTING GROUND WATER QUALITY.
Economic Research Service, Washington, DC. Resources and Technology Div.
W.-Y. Huang, and N. D. Uri.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 775-782, August 1989. 1 fig, 18 ref.

Descriptors: *Water pollution control, *Water quality management, *Groundwater pollution, *Groundwater management, *Groundwater quality, Model studies, Public policy, Pesticides, Fate of pollutants, Path of pollutants.

An analytical framework is presented that identifies the tradeoffs that a regional authority desiring to enhance groundwater quality is confronted with as it strives to balance the preferences of farmers and households while endeavoring to maximize net regional welfare. A policy model is developed relying on three decision components where the objective is one of identifying the trade-offs that a regional authority will be confronted with as it strives to balance the preferences of farmers and households while endeavoring to maximize net regional welfare. The basic rule developed indicates that the regional authority must choose a policy whereby any increase (decrease) in regional income as just equal to the decrease (increase) in net benefit to households. While the determination of an optimal tax was selected in the analysis to describe a modeling procedure aimed as assisting in the development of a policy for protecting groundwater quality, the analytical framework is equally applicable to other policy options directed at the same goal. The model developed does require a fair amount of information in terms of details on transport and fate of pesticides, dose-response relationships, and costs. However, the analytical framework does carefully delineate the nature of the problem that the regional authority must confront, and it does focus on the issues that must be considered when developing a policy directed at reducing groundwater contamination. (Author's abstract)
W90-04174

ECONOMIC EFFECTS OF SOIL CONDITIONS ON FARM STRATEGIES TO REDUCE AGRICULTURAL POLLUTION.
Maryland Univ., College Park. Dept. of Agricultural and Resource Economics.
F. M. Roka, B. V. Lessley, and W. L. Magette.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 821-827, August 1989. 2 fig, 5 tab, 16 ref.

Descriptors: *Nonpoint pollution sources, *Erosion control, *Water pollution control, *Water pollution sources, *Agricultural hydrology, *Economic evaluation, *Soil contamination, *Model studies, Leaching, Nitrates, Soil erosion.

Utilizing predictions of pollutant movement generated by the CREAMS model, the economics of reducing the field losses of sediment and nitrate percolation were compared between two soil types on each of two slopes common to the Upper Eastern Shore of Maryland. The soils considered

were Matapeake silt loam and Sassafras sandy loam textures on field slopes of 3.5% and 7.5%. A representative cash grain farm was used as a basis of comparison. Under assumptions of profit maximization, economics optimal cropping systems varied by slope. Results further indicated that relative cost-effectiveness of sediment or nitrate percolation control varied by soil type for both slopes considered. If controlling surface losses, such as sediment, is more important than controlling subsurface leaching, resources spent on the silt loam soil would be more cost-effective than resources spent on the sandy loam soil. If, on the other hand, nitrate leaching is a more serious environmental threat than soil erosion, cost-effectiveness increases on sandy loam as compared with silt loam soil. (Author's abstract)
W90-04179

EVALUATION OF CONSUMER NOTIFICATION UNDER THE SAFE DRINKING WATER ACT.
California Univ., San Francisco.
For primary bibliographic entry see Field 5F.
W90-04181

ASSESSMENT OF SEDIMENT PHOSPHORUS INACTIVATION, KEZAR LAKE, NEW HAMPSHIRE.
New Hampshire Dept. of Environmental Services, Concord.
J. N. Connors, and M. R. Martin.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 845-853, August 1989. 7 fig, 5 tab, 16 ref.

Descriptors: *Lake restoration, *Algal blooms, *Limiting nutrients, *Phosphorus, *Water quality, Aluminum sulfate, Sodium aluminate, Chlorophyll, Transparency.

Aluminum sulfate and sodium aluminate were utilized as sediment phosphorus inactivants to improve the water quality of a northeastern eutrophic lake. A four-year monitoring program has provided an extensive lake-database utilized to evaluate the short-term and long-term effectiveness of sediment phosphorus inactivation as a lake restoration technique. An immediate impact of treatment was marked by a reduction in hypolimnetic BOD and dissolved oxygen deficit, lower chlorophyll-a and phosphorus concentrations, improved transparency, and the elimination of obnoxious blue-green phytoplankton blooms. For two to three years after treatment, these parameters continued to exhibit both less variability and improved values over the pre-treatment conditions. The improved water quality conditions warranted an upgrade of the lake trophic status from eutrophic to mesotrophic. Four years after the treatment, the mean hypolimnetic total phosphorus and chlorophyll-a have increased and transparency has decreased from initial post-treatment levels. Although long-term trends show water quality decreased since the treatment, the water quality has stabilized at a level suitable for recreation. A major benefit is an increase in the average attendance at the lake by almost 2,000 people/summer. (Author's abstract)
W90-04182

EDUCATING RURAL COMMUNITY LEADERS IN WASTEWATER TREATMENT ALTERNATIVES.
Ohio State Univ., Columbus. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5D.
W90-04202

RESPONSE CAPABILITY IN WATER CONTAMINATION EMERGENCIES.
Arizona Water Resources Research Center, Tucson.
M. Waterstone.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1015-1022, October 1989. 2 tab, 18 ref.

Descriptors: *Water pollution treatment, *Water pollution control, *Drinking water, *Groundwater pollution, *Public health, *New Jersey, Water supply, Surveys, Emergency response.

Contamination of supplies by a wide variety of pollutants has long presented water managers with difficult problems. In the last fifteen years the issue of groundwater contamination has received a great deal of attention. Most work has focused on the source side of the problem. Questions have included: where do pollutants come from, how widespread is the problem, and what are the effects of the contaminants on human health and the environment. Very little work, however, has yet been done on the response side of this issue. Are water managers aware of water pollution problems (actual or potential) and their magnitude, and how well prepared are they to deal with contamination situations if they should develop. The study was intended to assess both the methodological and substantive issues involved in an empirical investigation of response capability. At present, very little systematic information exists regarding the degree to which water managers and providers are prepared for, and capable of responding to contamination (or other water) emergencies. The assessment of 212 municipalities in southern New Jersey indicates that although problem awareness is fairly high, actual preparedness, knowledge, and implementation capabilities are remarkably, and uniformly, low. Given the fact that a sizable population in this region depends on groundwater for potable supplies, this vulnerability to contamination and the potential lack of adequate response would appear to be cause for concern. (Author's abstract)
W90-04205

IN SITU IMMOBILIZATION OF HEAVY-METAL CONTAMINATED SOIL.
Foster-Miller Associates, Inc., Waltham, MA.
G. Czupryna, R. D. Levy, A. I. Maclean, and H. Gold.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A2011 244. Price codes: A06 in paper copy, A01 in microfiche. Report No. ESL-TR-87-17, June 1988. 138p, 19 fig, 49 tab, 35 ref, 2 append.

Descriptors: *In situ treatment, *Heavy metals, *Soil contamination, *Water pollution prevention, Hazardous wastes, Chromium, Cadmium, Nickel, Chemical treatment, Costs, Military reservations, Cleanup, Leachates.

Dynamic-flow column studies were conducted at various Air Force Air Logistics Centers to obtain detailed data on the maximum capacity and mobility of metal contaminants in soil with and without the addition of the best treatment chemicals. Long-term column tests on the stability and leachability of the best treatment chemicals with and without the effects of acid rain and solvent addition were also carried out. Finally, tests were performed in a Hazardous Waste Site Simulator over a 4-month period to determine the immobilization of hexavalent chromium, cadmium and nickel in treated soil against a dynamically changing environment. The results of the column studies showed that the use of a Valfor 200/ferrous sulfate combination for the immobilization of hexavalent chromium, cadmium, and nickel proved very effective in treating soils from McClellan AFB and Robins AFB. Long-term stability tests with soils contaminated with only hexavalent chromium showed that very little, if any, leaching occurred with simulated acid rain (pH 5.3), deionized water, and water saturated with a solvent (toluene) leachate solution, indicating that the treatment chemicals and the metal complexes they formed were stable over the test period (25 days). The primary cost of in situ immobilization treatment is the cost of the chemical treatment additive; the application costs are < 5% of the chemical costs. The estimated chemical costs to treat soil contaminated with 30 milliequivalents of total metal/kg soil ranged from $33,300/acre-ft to $81,200/acre-ft, or $13.9/ton to $33.8/ton. (Lantz-PTT)
W90-04215

VIRGINIA'S GROUNDWATER.
For primary bibliographic entry see Field 2F.
W90-04221

REMEDIES AT EXISTING FACILITIES.
T. M. Johnson.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 21-33, 9 fig, 1 tab, 15 ref.

Descriptors: *Water pollution treatment, *Water pollution prevention, *Groundwater pollution, *Groundwater quality, *Cleanup operations, Landfills, Leachates, Slurries, Ground curtains, Cutoff walls, Sealants, Extraction, Chemical treatment, Excavation.

A study of more than 120 documented case histories of groundwater contamination incidents revealed that remedial action is usually complex, time consuming, and expensive. Generally, the longer it takes to discover contamination in the subsurface, the larger the zone of contamination is likely to be and the more likely the possibility that groundwater will become polluted. The corrective action necessary to renovate groundwater is complicated by several factors: (1) contamination usually is not discovered until contaminants have flowed some distance through the subsurface; (2) there is normally no simple way to determine the extent of contamination. In most cases, too few wells are in an affected area to delineate the extent of the pollution. Therefore, it is often necessary to drill wells or borings to define the zone of contamination; (3) finding the course of groundwater contamination is often a major problem. Contaminants may undergo changes in the subsurface that make them hard to identify; and (4) groundwater renovation is further complicated by the variable behavior of contaminants in the subsurface environment. A manual was compiled of the available methodology for implementing remedial measures at waste disposal sites. It emphasizes procedures that reduce the amount or concentration of contaminants and prevent or redirect contaminant movement from the disposal site. The manual describes various engineering methods for controlling pollution and estimates their costs when applied to a hypothetical landfill site. The methods emphasized in the manual, and discussed in the paper, are: hypothetical landfill, leachate production, leachate control, surface water control, passive methods, slurry trenches, grout curtains, sheet-piling cutoff wall, bottom sealing, active methods, extraction, injection, leachate handling, chemical immobilization, chemical fixation, chemical injection, and excavation and reburial. (See also W90-04221) (Lantz-PTT)
W90-04223

REMEDIAL METHODS FOR POLLUTED AQUIFERS.
National Water Well Association, Worthington, OH.
D. M. Nielsen.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 34-44, 10 fig, 20 ref.

Descriptors: *Water pollution treatment, *Restoration, *Cleanup operations, *Groundwater pollution, *Aquifers, Containment, Grout curtains, Cutoff walls, Aquifer restoration, Selective withdrawal, Groundwater recharge, Biodegradation, Chemical treatment.

The containment and/or control of contaminated groundwater can generally be accomplished using one or a combination of several available techniques. The alternatives available for remedial action can be broken down into three broad categories, (1) physical containment measures including slurry-trench cutoff walls, grout curtains, and sheet piling; (2) aquifer rehabilitation including withdrawal, treatment, and reinjection (or recharge), and in situ treatment such as chemical neutralization and biodegradation; and (3) withdrawal, treatment, and use. Often, site conditions dictate that more than one of the available methods be used to meet the reclamation goals of specific sites. It is not possible to develop a specific program of remedial action applicable to all situations,

but is possible to prepare containment/control strategies for most groundwater contamination incidents. (See also W90-04221) (Lantz-PTT)
W90-04224

DEVELOPING ALTERNATIVES TO LANDFILLS.
For primary bibliographic entry see Field 5E.
W90-04225

STATE MONITORING PROGRAMS.
L. S. Graves.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 52-54.

Descriptors: *Network design, *Groundwater pollution, *Monitoring, *Water quality control, State jurisdiction, Water sampling, Data acquisition, Chemical analysis, Water pollution control.

In and of itself, groundwater monitoring does not prevent groundwater contamination. At best, monitoring can only detect contamination that has entered the aquifer and then set into motion actions to minimize further spread of the contaminants. Detecting groundwater contamination before extensive damage occurs depends on the nature of the monitoring system. At the outset, a distinction can be made between groundwater monitoring conducted within a state and what might be termed formal state groundwater monitoring programs. In most states, groundwater monitoring is conducted through a patchwork of legislative authorities and resource management programs. Each program operates independently with different objectives and informational needs. Few states have organized and coordinated these separate programs into a single state groundwater monitoring program where the data from different sources are readily accessible and duplication of effort is minimized. An fine example of a formal state monitoring program is that of New Jersey. All groundwater monitoring programs have three basic components that must be determined before implementing a program: (1) the location and number of monitoring points; (2) the type of chemical parameters to be analyzed. Some state programs limit their analyses to inorganic constituents, while other programs include some man-made organic compounds; and (3) the frequency of sample extraction and analysis. For purposes of illustrating the variations in these components and the nature of groundwater monitoring systems in general, monitoring that is conducted within states can be divided into two broad categories. The first category is regional baseline or ambient groundwater quality monitoring, and the second category is site-specific monitoring. (See also W90-04221) (Lantz-PTT)
W90-04226

NEW JERSEY'S PROGRAM.
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
A. Schiffman.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 55-61.

Descriptors: *New Jersey, *Groundwater quality, *Water quality management, *Regulations, Legal aspects, Standards, Permits, Legislation.

A comprehensive groundwater resource management program was established in New Jersey in 1980 to protect major aquifers vulnerable to contamination from landfill leachate, lagoon seepage, septic tank leakage, underground injection, hazardous materials spills, improper disposal of industrial wastes, and a variety of other sources of pollutants. The legal basis for New Jersey's groundwater programs includes the following laws which form the statutory basis for the administration of New Jersey's groundwater programs: Department of Environmental Protection Statute, Water Pollution Control Act, Water Quality Planning Act, Spill Compensation and Control Act, Water Supply Management Act, and the Safe Drinking Water Act. In an effort to develop and administer the ways and means for groundwater protection, the Division of Water Resources utilizes a multifaceted approach, which is demonstrated in the following programs: Bureau of Ground Water Discharge permits, New Jersey Geological Survey--which provides geologic, geohydrologic, geophysical, and geodetic information, advice, and assistance to state and local governments, public and private organizations, and the citizens of New Jersey; Bureau of Water Supply Planning--whose primary function is to administer the various planning programs set forth in the Statewide Water Supply Master Plan (SWSMP) under the authority of the Water Supply Management Act; Bureau of Water Allocation; Bureau of Potable Water--which institutes the overall management of work programs and activities to ensure a desirable and effective comprehensive statewide drinking water program; Enforcement--whose major activities include the identification and mitigation of sources of groundwater contamination, permit compliance monitoring inspections, and permit compliance activities; and Laboratory Certification--which ensures the quality of water sample analysis. (See also W90-04221) (Lantz-PTT)
W90-04227

LOCAL OPTIONS FOR GROUNDWATER PROTECTION.
G. R. St. John.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 62-64.

Descriptors: *Water quality management, *Groundwater quality, *Local governments, *Regulations, Legal aspects, Zoning, Ordinances.

Groundwater protection at the local level falls into two logical categories: prevention of contamination before it happens and remedial action after it happens. In either of these two areas, the means of accomplishment fall into three categories: legal compulsion, persuasion, and direct action by the locality at its own expense. In the area of prevention through legal compulsion, the tools of the locality are its ordinances, chiefly the zoning ordinance if it is properly written. The zoning ordinance is very effective in protecting the environment from damage by private industrial, commercial, and residential enterprises. It is ineffective in controlling the activities of state and federal government agencies (they are not subject to it) and agricultural and individual polluters (for example, the fellow who changes his own oil and dumps it in the woods). An outline is presented of how the zoning ordinance should work to prevent and remediate pollution. The key is the site plan. Its role is to expose a proposed project to review by all appropriate state agencies, get their recommendations, and then convert those recommendations into binding rules with the force of law, as conditions of approval. (See also W90-04221) (Lantz-PTT)
W90-04228

CLASSIFYING AQUIFERS.
For primary bibliographic entry see Field 2F.
W90-04229

ELEMENTS OF A GROUNDWATER MANAGEMENT PROGRAM.
ICF, Inc., Washington, DC.
J. D. Werner.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 76-79.

Descriptors: *Groundwater management, *Water quality management, *Groundwater pollution, *Hazardous waste disposal, Environmental protection, Classification, Degradation, Management planning, Aquifers, Groundwater quality, Monitoring, State jurisdiction.

There are a number of key elements of the groundwater protection and contamination issue: aquifer restoration, state groundwater classification, and alternatives to land disposal of wastes. Results from a study on groundwater protection programs from 36 states, focus on water quality management and it's three broad elements: goal selection (through non-degradation, limited degradation and differential protection), management strategy selection, and program implementation. Some states are trying, with varying degrees of success, to have their groundwater protection strategy serve the dual purposes of regulating nonpoint surface water pollution and controlling hazardous waste facility siting. An aquifer classification system can be considered a type of management strategy because a state decides which aquifers can be degraded and which cannot and manages the areas accordingly. A number of states view hazardous waste facilities as their biggest problem. An increased level of monitoring is needed, especially around hazardous waste facilities. (See also W90-04231) (Lantz-PTT)
W90-04230

FEDERAL INVOLVEMENT IN GROUNDWATER PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
M. Mlay.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 82-84.

Descriptors: *Federal jurisdiction, *Groundwater quality, *Water quality control, Legal aspects, Regulations, Legislation, State jurisdiction, Public policy, Institutions.

The US EPA recently has been developing its groundwater protection strategy, which deals with groundwater protection through a number of federal laws designed for different purposes, usually to control specific kinds of substances at particular kinds of facilities. These laws include, but are not limited to the: Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund); (2) Resource Conservation and Recovery Act (RCRA); (3) Underground Injection Control (UIC) program; (4) Sole-Source Aquifer (SSA) program; (5) Public Water System (PWS) program; (6) Clean Water Act (CWA); (7) Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); and (8) Toxic Substances Control Act (TSCA). With rare exception, none of these laws really focuses specifically on groundwater resources. Such a focus on groundwater must take place at the state level. Through the groundwater protection strategy, EPA will support state program development efforts, develop guidelines that will make its programs more compatible, address such sources of contamination as leaking storage tanks, and develop an institutional focus within the agency to enable it to work closely with the states to enhance their efforts to protect groundwater in a comprehensive manner. (See also W90-04221) (Lantz-PTT)
W90-04231

LEGAL AUTHORITY TO PROTECT GROUNDWATER IN VIRGINIA.
For primary bibliographic entry see Field 6E.
W90-04232

PROGRAMS TO PROTECT GROUNDWATER IN VIRGINIA.
Virginia State Water Control Board, Richmond.
R. N. Burton.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 90-92.

Descriptors: *Virginia, *Groundwater quality, *Legislation, *Water quality control, State jurisdiction, Institutions, Monitoring, Water pollution control, Groundwater management, Permits.

An overview of groundwater resources in Virginia mentions those resources in the Coastal Plain province, the Piedmont province, the Blue Ridge province, the Valley and the Ridge provinces, and the Cumberland Plateau. Potential sources of pollution of these resources include underground storage tanks, septic tanks, poorly constructed wells, open waste dumps, agricultural and industrial wastes. To protect groundwater from pollution and promote reasonable care in daily activities, the state has adopted the State Water Control Law. Under this law and others, the state water control board maintains a number of programs to prevent, detect, and mitigate groundwater pollution. These programs include the: (1) groundwater quality monitoring; (2) salt water intrusion monitoring; (3) pollution response; (4) groundwater data; (5) site evaluation; (6) groundwater management program; (7) National Pollutant Discharge Elimination System (NPDES) permit; (8) surface impoundment assessment; and (9) groundwater research drilling. (See also W90-04221) (Lantz-PTT)
W90-04233

EVALUATION OF CONTROL CHART METHODOLOGIES FOR RCRA WASTE SITES.
Nevada Univ., Las Vegas. Environmental Research Center.
T. H. Starks.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-138416. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/4-88/040, January 1989. 40p, 3 fig, 13 tab, 27 ref. EPA Contract CR 814342-01-3.

Descriptors: *Water quality control, *Hazardous wastes, *Resource Conservation and Recovery Act, *Groundwater quality, *Monitoring, Statistical methods, Model studies.

This report is a discussion of decision rules relating to the monitoring of groundwater at hazardous waste sites that are subject to regulation under the Resource Conservation and Recovery Act of 1976 (RCRA). The final rule for RCRA regulations 40 CFR part 264 was published October 1, 1988. Understanding the complexity of the monitoring problem and the diversity of RCRA sites, the final rule wisely allows the owner/operator to choose, conditioned on EPA approval, a site-specific 'statistical procedures.' These methods are discussed to facilitate the choice of decision rules. A nested random-effects model for groundwater quality parameter measurements is suggested and decision procedures are developed in terms of that model. Particular attention is paid to the possible application of industrial quality control strategies to the groundwater monitoring problem. A decision procedure that changes over time as more information about well and aquifer characteristics accumulate is proposed. This procedure involves the use of outlier tests and of Shewhart-CUSUM quality control strategies. (Author's abstract)
W90-04247

STATISTICAL ANALYSIS OF GROUNDWATER MONITORING DATA AT RCRA FACILITIES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 7A.
W90-04250

SUPERFUND RECORD OF DECISION: INDUSTRIAL WASTE CONTROL, AR.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-153761. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/036, June 1988. 74p, 4 fig, 3 tab, 5 append.

Descriptors: *Industrial wastes, *Superfund, *Cleanup operations, *Water pollution sources, *Arkansas, *Landfills, Volatile organic compounds, Phenols, Solid wastes, Arsenic, Toluene, Capping, Stabilization, French drains, Strip mines, Heavy metals.

The 8-acre Industrial Waste Control (IWC) site, an abandoned coal strip mine, is a closed industrial waste landfill about 8 miles southeast of Fort Smith near Jenny Lind, Sebastian County, Arkansas. Landfilling operations began in the late 1960s or early 1970s and primarily dealt with municipal refuse and debris, and industrial trash. In August 1974, the site was purchased by Grady Shipley and granted an industrial landfill permit by the Arkansas Department of Pollution and Ecology. The site received a wide variety of liquid wastes (including methylene chloride, phenols, cresylic acid, and paints), solid wastes, and sludges. In addition, the site possibly contains about 9,000 buried drums. In March 1977, surface impoundments overflowed and contaminated a local pond and pastures north of the site resulting in a fish kill in the pond and the death of several cattle. Consequently, the site was covered, recontoured, and closed by the State in 1978. Four areas of contamination have been identified at the site. The primary contaminants of concern affecting the soils, sediments, groundwater and surface water include: volatile organic compounds (VOCs) including toluene, organics, and metals including arsenic, chromium, and lead. The selected remedial action for this site includes: installation of a french drain along the south, west and east sides of the site with a synthetic liner or other barrier, such as a slurry wall installed on the site side of the french drain; groundwater pump for offsite treatment, mixture with the contaminated soil and stabilized onsite, or treatment in an onsite facility with discharge to be determined during design; multilayer Resource Conservation and Recovery Act (RCRA) capping to cover the area bound by the french drain system and the northern site border; surface water diversion using ditches and berms; access and land use restrictions; and groundwater and site monitoring. The estimated present worth cost for this remedial action is $11,400,000. (Lantz-PTT)
W90-04257

SUPERFUND RECORD OF DECISION: CHISMAN CREEK, VA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-153803. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/044, March 1988. 43p, 4 fig, 16 tab.

Descriptors: *Land disposal, *Path of pollutants, *Superfund, *Cleanup operations, *Water pollution sources, *Virginia, Chisman Creek, Water pollution treatment, Fly ash, Groundwater pollution, Borrow pits, Wells.

The Chisman Creek site is located near Grafton in York County, Virginia. This Record of Decision (ROD) addresses operable unit two, which consists of three ponds, the freshwater tributary, and the Chisman Creek estuary. The site is located within the watershed of Chisman Creek, a tributary of the Chesapeake Bay. Approximately 500 to 1,000 people live within one mile of the site. Between 1957 and 1974, fly ash from the Virginia Power Yorktown Power Generating Station was disposed of in four abandoned sand and gravel borrow pits located south of the generating station. The fly ash disposal areas, designated Areas A, B, C, and D, became known as the Chisman Creek Superfund site. Between 1971 and 1973, all fly ash in Area D was removed and deposited in Area C. Area D was reportedly filled with construction rubble generated during the construction of public utilities in the area at that time. After a domestic well showed discolored water in 1980, the Virginia State Water Control Board (SWCB) and Virginia State Board of Health sampled residential groundwater in the vicinity of the fly ash areas to determine the types and concentrations of contaminants present. The Virginia Institute of Marine Science and SWCB conducted additional studies to determine the nature and extent of area contamination. The first operable unit ROD was signed in September 1986, and the remedial action began in November 1987. (Author's abstract)
W90-04258

VOC CONTAMINATION AT SELECTED WISCONSIN LANDFILLS--SAMPLING RESULTS AND POLICY IMPLICATIONS.
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 5B.
W90-04270

WATER PROBLEMS OF URBANIZING AREAS.
For primary bibliographic entry see Field 4C.
W90-04338

SECTION 208 PLANNING PROCESS--THE FEDERAL VIEW.
Environmental Protection Agency, Washington, DC. Water Planning Div.
For primary bibliographic entry see Field 6E.
W90-04339

STATE ASPECTS OF 208 PLANNING.
Virginia State Water Control Board, Richmond. Bureau of Water Control Management.
For primary bibliographic entry see Field 6E.
W90-04340

EXPERIENCES AND PERCEPTIONS OF THE 208 PROGRAM AT THE SUBSTATE LEVEL.
Middlesex County Planning Board, New Brunswick, NJ.
For primary bibliographic entry see Field 6A.
W90-04341

INSTITUTIONAL PROBLEMS IN IMPLEMENTING WATER QUALITY CONTROL.
Colorado State Univ., Fort Collins. Dept. of Political Science.
For primary bibliographic entry see Field 6E.
W90-04343

STRATEGIES TO OBTAIN WATER QUALITY CONSISTENT WITH OTHER OBJECTIVES.
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
J. G. Moore.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 53-55.

Descriptors: *Urban hydrology, *Governmental interrelations, *Water pollution control, *Water quality management, *Water quality control, *Management planning, *Regulations, Urbanization, Institutions, Water conservation, Water reuse.

In strategies to achieve water quality, well-meaning laws, regulations, budgets and plans may only result in 'over promising' and unrealistic expectations, unless they are tied to purposeful action. It is the action and interaction of people which is of fundamental importance. Since it is people that pollute, the size and complexity of the problem generally parallels the areal or geographic distribution of population. Any strategy to obtain water quality must consider these factors, since increasing population and a rising standard of living multiply the adverse effects on the environment. Therefore, the restoration and maintenance of a desired level of water quality must be approached either by confronting the growth issue directly through birth control and austerity, or by accepting growth as inevitable and directing it. The latter strategy may be aided by land use planning. Essential to any strategy to achieve water quality is a recognition that the major efforts must be institutional, since the basic problems are political or 'people' problems. In metropolitan areas, an attempt should be made to devise new forms of government, as substitutes for the existing multiple competing political subdivisions of cities and coun-

ties, in order to make multilateral interaction possible on an area-wide basis in place of the traditional bilateral interaction. In addition, conservation and water reuse are vital. Conservation should include an expanded investment in the reuse of human wastewater, Very dramatic reductions in the total volume of water used in this country can only be made by reducing the quantity used for irrigation. Only a very small quantity is actually ingested by man. Perhaps ways to treat drinking water to an extremely high level should be considered while providing a lesser level of treatment for municipal, industrial and agricultural uses. Planning must also take into account the interrelationships among the various Federal laws and their ensuing regulations. (See also W90-04338) (Lantz-PTT)
W90-04344

CONTROL OF URBAN RUNOFF AND NONPOINT SOURCE POLLUTION.
Massachusetts Univ., Amherst. Water Resources Research Center.
B. B. Berger.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 80-89.

Descriptors: *Urban hydrology, *Water pollution control, *Urban runoff, *Water pollution prevention, *Combined sewers, *Nonpoint pollution sources, *Water pollution control, *Water quality control, Costs, Economic aspects, Management planning, Primary wastewater treatment, Physical treatment, Model studies.

The possible use of combined sewers should be given renewed consideration in the context of controlling nonpoint source (NPS) pollution. Studies should be made of the feasibility of their use in situations where treatment of storm runoff is required. Control at the ultimate source of pollutants is important with research conducted to provide a better understanding of ultimate sources, e.g., dry fallout and heavy metals. There is a need to evaluate quantitatively the effectiveness and costs of the Best Management Plan (BMP) on NPS pollution reduction, e.g., street sweeping. Detention storage appears to be a reasonable control mechanism in the sense that it represents a means of removal of suspended solids. However, the effects of detention storage on water quality need to be determined quantitatively. Investigations also need to be made about alternatives to detention storage, e.g., directing first flush into the sanitary system. Primary treatment of NPS pollution is reasonable, e.g., in conjunction with detention storage. Separators also show technical promise, but they require cost-effective analysis. Even though there is a relatively high level of uncertainty associated with quality models (compared with quantity), more complex models are not needed at this time. There are two fundamental problems regarding quality models: (1) in some cases the basic question of cause and effect concerning specific pollutants is not known or well understood; and (2) the purpose of the model itself is not understood and therefore can be misused. A lack of available data for calibration and loading purposes creates a need for a long-term, well planned data gathering program; the U. S. Geological Survey urban data program appears to have the potential of satisfying this need. (See also W90-04338)(Lantz-PTT)
W90-04348

DATA GATHERING FOR STORMWATER RUNOFF AND SURVEILLANCE.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7B.
W90-04349

EFFECT OF POLLUTANTS ON BIOTA.
Michigan Dept. of Natural Resources, Lansing.
For primary bibliographic entry see Field 5C.
W90-04350

MAINTENANCE OF INSTREAM FLOWS.
Michigan State Univ., East Lansing. Inst. of Water Research.
For primary bibliographic entry see Field 2E.
W90-04351

EUTROPHICATION AND LAKE MANAGEMENT.
Maine Univ. at Orono. Land and Water Resources Center.
For primary bibliographic entry see Field 2H.
W90-04352

POLLUTION OF GROUNDWATER.
Princeton Univ., NJ. Water Resources Program.
For primary bibliographic entry see Field 5B.
W90-04353

RELATIONSHIP OF WATER QUALITY TO AGRICULTURE AND TO EROSION.
Fairfax County Dept. of Environmental Management, VA.
For primary bibliographic entry see Field 4D.
W90-04354

WATER QUALITY EFFECTS OF LAND USE MANAGEMENT AND VEGETATION.
Illinois State Dept. of Transportation, Chicago. Div. of Water Resources.
For primary bibliographic entry see Field 4C.
W90-04355

PROTECTION OF LAKES AND WETLANDS.
Rutgers - The State Univ., New Brunswick, NJ. Water Resources Research Inst.
A. W. McIntosh.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 157-167, 8 ref.

Descriptors: *Planning, *Urban hydrology, *Water pollution control, *Lakes, *Wetlands, *Water quality management, Water quality, Lake management, Research priorities, Public policy, Economic aspects.

Appropriate statutory authority exists to manage lakes and wetlands, but the database for decision making is weak, and many technical problems are unresolved. Each water body has certain site-dependent features which preclude broad generalized solutions, and classification requires a different perspective and prescription for aid. In the long run, for control measures to be effective, continuous vigil management in perpetuity seems required. Specific problem areas related to lakes and wetlands which need further study include the following: toxics, viruses, nutrients, societal preferences, sediment, erosion, vulnerability to sabotage, and role of lakes in regional or local water reuse schemes. Only in recent years have wetlands been looked upon as a valuable resource, as opposed to a nuisance. Problems related to slow acceptance of their importance are the absence of public support and lack of understanding of these specialized water system. Other issues addressed included the following: who pays for lake management in developing and developed areas; cost-benefit determinations in lake management; funding sources of lake and wetland protection and control; developing an appropriate database; the role of zoning and regulation in lake front development; and where limited Federal dollars do the most good in addressing the spectrum of problems being faced. (See also W90-04338)(Lantz-PTT)
W90-04356

DATA GATHERING FOR NPS AND ILLEGAL DISCHARGES.
Metropolitan Sanitary District of Greater Chicago, IL. Dept. of Research and Development.
For primary bibliographic entry see Field 7B.
W90-04358

COSTS AND FINANCING OF WATER QUALITY CONTROL.
Georgia Univ., Athens. Inst. of Natural Resources.
For primary bibliographic entry see Field 6C.
W90-04359

MOST APPROPRIATE ONGOING WASTEWATER INSTITUTIONS (ORGANIZATION FOR AREAWIDE WATER QUALITY PLANNING).
Colorado State Univ., Fort Collins. Dept. of Political Science.
For primary bibliographic entry see Field 6E.
W90-04360

WASTEWATERS: A PERSPECTIVE.
Environmental Protection Agency, Atlanta, GA. Region IV.
A. J. Smith.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 3-4.

Descriptors: *United States, *Wastewater management, *Clean Water Act, *Financing, Loans, Lakes, Reservoirs, Industrial wastes, Water quality control, Toxic wastes, Municipal wastes, Wetlands, Nonpoint pollution sources.

The 1987 Water Quality Act amendments to the Clean Water Act established a new direction in wastewater management. The federal grants program for municipal wastewater treatment works will be phased out in 1990 and replaced with a State Revolving Loan Program funded through 1994. Although federal funds will be declining, problems remain to be solved, including: (1) treatment works construction for communities of less than 10,000 population, estimated to cost between $10 and $15 billion nationwide; (2) agricultural nonpoint pollution, which is a cause of serious water quality problems in 24 states; (3) impaired water quality in lakes and reservoirs, mainly due to agricultural pollution; (4) large treatment needs in the industrial sector (e.g., acid mine drainage in Appalachia); (5) landfill leachates from both industrial and municipal solid wastes; and (6) industrial toxic chemical and hazardous waste treatment. Wetland systems represent one way to attempt to deal with these problems in an era of declining federal funding and increased concerns about water quality. (See also W90-04392) (Rochester-PTT)
W90-04393

WETLANDS ECOSYSTEMS: NATURAL WATER PURIFIERS.
Tennessee Valley Authority, Knoxville. Waste Technology Program.
For primary bibliographic entry see Field 5D.
W90-04394

CONSTRUCTED FREE SURFACE WETLANDS TO TREAT AND RECEIVE WASTEWATER: PILOT PROJECT TO FULL SCALE.
Humboldt State Univ., Arcata, CA. Dept. of Environmental Resources Engineering.
For primary bibliographic entry see Field 5D.
W90-04400

ISELIN MARSH POND MEADOW.
Indiana Univ. of Pennsylvania.
For primary bibliographic entry see Field 5D.
W90-04401

INTEGRATED WASTEWATER TREATMENT USING ARTIFICIAL WETLANDS: A GRAVEL MARSH CASE STUDY.
San Diego State Univ., CA. Graduate School of Public Health.
For primary bibliographic entry see Field 5D.
W90-04402

SEWAGE TREATMENT BY REED BED SYSTEMS: THE PRESENT SITUATION IN THE UNITED KINGDOM.
Water Research Centre, Stevenage (England).

For primary bibliographic entry see Field 5D.
W90-04403

AQUATIC PLANT/MICROBIAL FILTERS FOR TREATING SEPTIC TANK EFFLUENT.
National Aeronautics and Space Administration, Bay Saint Louis, MS. John C. Stennis Space Center.
For primary bibliographic entry see Field 5D.
W90-04404

CREATION AND MANAGEMENT OF WETLANDS USING MUNICIPAL WASTEWATER IN NORTHERN ARIZONA: A STATUS REPORT.
Apache-Sitgreaves National Forests, Lakeside, AZ.
For primary bibliographic entry see Field 5D.
W90-04405

LAND TREATMENT OF MUNICIPAL WASTEWATER ON MISSISSIPPI SANDHILL CRANE NATIONAL WILDLIFE REFUGE FOR WETLANDS/CRANE HABITAT ENHANCEMENT: A STATUS REPORT.
Mississippi Sandhill Crane National Wildlife Refuge, Gautier.
For primary bibliographic entry see Field 5D.
W90-04406

WASTE TREATMENT FOR CONFINED SWINE WITH AN INTEGRATED ARTIFICIAL WETLAND AND AQUACULTURE SYSTEM.
National Fertilizer Development Center, Muscle Shoals, AL.
For primary bibliographic entry see Field 5D.
W90-04407

TREATMENT OF ACID DRAINAGE WITH A CONSTRUCTED WETLAND AT THE TENNESSEE VALLEY AUTHORITY 950 COAL MINE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D.
W90-04408

CONSTRUCTED WETLANDS FOR TREATMENT OF ASH POND SEEPAGE.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D.
W90-04409

USE OF WETLANDS FOR TREATMENT OF ENVIRONMENTAL PROBLEMS IN MINING: NON-COAL-MINING APPLICATIONS.
Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.
For primary bibliographic entry see Field 5D.
W90-04410

CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT AT AMOCO OIL COMPANY'S MANDAN, NORTH DAKOTA REFINERY.
Amoco Oil Refinery, Mandan, ND.
For primary bibliographic entry see Field 5D.
W90-04411

UTILIZATION OF ARTIFICIAL MARSHES FOR TREATMENT OF PULP MILL EFFLUENTS.
Weyerhaeuser Co., Tacoma, WA. Technology Center.
For primary bibliographic entry see Field 5D.
W90-04412

USE OF ARTIFICIAL WETLANDS FOR TREATMENT OF MUNICIPAL SOLID WASTE LANDFILL LEACHATE.
Cornell Univ., Ithaca, NY. Center for Environmental Research.
For primary bibliographic entry see Field 5D.
W90-04413

USE OF WETLANDS FOR URBAN STORMWATER MANAGEMENT.
Florida State Dept. of Environmental Regulation, Tallahassee.
E. H. Livingston.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 253-262, 17 ref.

Descriptors: *Wetlands, *Land disposal, *Florida, *Urban runoff, *Storm water, *Wastewater treatment, *Artificial wetlands, Biological wastewater treatment, Water pollution control, Sediments, Macrophytes, Rainfall, Storms, Maryland, Legislation, Regulations, Flushing.

Use of wetlands for urban stormwater management should not be considered a panacea. Little scientific information is available concerning the short-term or long-term effects on wetlands, their natural functions, or associated fauna from the addition of stormwater. Most water quality effects of stormwater result from 'first flush.' In Florida, this corresponds to the first 2.5 cm of rainfall, which carries 90% of the pollution load from a storm event. Pretreatment removes heavy sediment loads and other pollutants such as hydrocarbons that can damage the wetland. Pretreatment also attenuates stormwater volumes and peak discharge rates to maintain the wetland hydroperiod and reduce scour and erosion. Wetland plants have specific tolerances to levels and types of pollutants. Polluted stormwater contains increased nutrients, which may change the plant community. Since new dominants reflect more efficient use of added nutrients or are more tolerant to pollutants, the plant changes should benefit pollutant removal. In 1982, Maryland legislation required development of stormwater management regulations to ensure that stormwater from new developments was treated to reduce the pollutant discharged to receiving water. The same year, the Florida Stormwater Rule was implemented, requiring all newly constructed stormwater discharges to use appropriate best management practices (BMPs) to treat the first flush of runoff. Vegetated systems, wet detention, or wetlands are commonly used BMPs. Wetlands have great potential to help solve stormwater management problems. However, more information is needed to ascertain possible effects on wetlands and their fauna from addition of untreated stormwater. Litile is known about the potential for bioaccumulation of heavy metals or other toxics typical of stormwater. Monitoring of wetland stormwater systems also is essential to determine relations between design variables and pollutant removal efficiency. (See also W90-04392) (Rochester-PTT)
W90-04414

USE OF WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT AND DISPOSAL: REGULATORY ISSUES AND EPA POLICIES.
Environmental Protection Agency, Washington, DC. Office of Municipal Pollution Control.
R. K. Bastian, P. E. Shanaghan, and B. P. Thompson.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 265-278, 1 fig, 27 ref.

Descriptors: *Land disposal, *Water pollution control, *Wastewater treatment, *Clean Water Act, *Wetlands, *Administrative regulations, Environmental Protection Agency, Biological wastewater treatment, Water pollution control, Policy making, Artificial wetlands, Macrophytes, Grants, Financing, Federal jurisdiction.

Wetlands provide high levels of wastewater treatment, but concern has been expressed over (1) possible effects from of toxic materials and pathogens in wastewaters and (2) long-term degradation of wetlands from wastewater discharges. Constructed wetlands employ wetland vegetation to assist in treating wastewater in a more controlled environment than occurs in natural wetlands. Regulatory issues and Environmental Protection Agency (EPA) policies involved in wastewater treatment with constructed wetlands are considered. Both natural and constructed treatment systems have achieved high removal efficiencies for BOD5, suspended solids, nutrients, heavy metals, trace organic compounds, and pathogens from municipal wastewater. In many areas, natural wetlands serve as receiving waters for permitted discharges of treated wastewater. More than 400 such discharges exist in the Southeast and another 100 occur in the Great Lakes States. In arid regions, wastewater effluents are often used to create, maintain, restore, or enhance wetlands. There are several circumstances under which wetlands are considered 'waters of the United States' under 40 CFR Part 122.2; most natural wetlands are included, but most constructed wetlands are excluded from this definition. In addition to meeting minimum technology requirements, discharges to waters of the United States must comply with applicable state water quality standards. Very few states have established separate water quality standards for wetlands, and EPA has not developed water quality criteria specifically for wetlands. When altering natural wetlands for use in wastewater treatment, it generally is necessary to obtain a permit under section 404 of the Clean Water Act. A recent EPA task force concluded that natural wetlands should be viewed primarily as protected water bodies and that, in the absence of water quality criteria for wetlands, it is impossible to identify broadly conditions where they could be safely regarded as part of the 'treatment system.' EPA encourages the use of constructed (artificial) wetlands through the innovative and alternative technology provisions of its construction grants program. (See also W90-04392) (Rochester-PTT)
W90-04415

STATES' ACTIVITIES, ATTITUDES AND POLICIES CONCERNING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Div. of Water Pollution Control, Nashville.
R. L. Slayden, and L. N. Schwartz.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 279-286, 14 ref.

Descriptors: *Land disposal, *Water pollution control, *Wastewater treatment, *Wetlands, *Regulations, *Artificial wetlands, Tennessee Valley Authority, Biological wastewater treatment, Water pollution control, Policy making, State jurisdiction, Alabama, California, Florida, Kentucky, South Dakota, Tennessee, Texas, Virginia.

A cross section is presented of current activities, attitudes, and policies of individual states concerning constructed wetlands for wastewater treatment. States discussed here were chosen because of previous contact with the Tennessee Valley Authority. The information presented is a synopsis of a telephone survey of state regulatory agencies conducted in May 1988 or a review of their published papers. States covered include: Alabama, California, Florida, Kentucky Mississippi, Missouri, North Carolina, Pennsylvania, South Dakota, Tennessee, Texas, and Virginia. The survey shows a wide spectrum of activities and attitudes concerning constructed wetlands. Few states have hard-and-fast policies or criteria on this technology. Everyone agrees there is still much to be learned about the optimization of the process. Some states are more willing to approve presently imperfect examples in an effort to further the knowledge of the system. Most contacted states have several examples of wetlands systems, and South Dakota is planning to build 20 to 30. When states are asked if they are promoting constructed wetlands, some reply that promotion of certain types systems is not their responsibility--that they only review what is submitted. It is suggested that it is the responsibility of state regulators to encourage the use of improved systems. If state regulators continue to blindly approve whatever is submitted, nothing is accomplished but perpetuation of a de-

plorable situation. Places where constructed wetlands can be used should be sought. Information about successful projects will spread quickly. The constructed wetland may prove to be the best wastewater treatment alternative to appear in some time. (See also W90-04392) (Rochester-PTT)
W90-04416

PRELIMINARY CONSIDERATIONS REGARDING CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Office of Surface Mining Reclamation and Enforcement (DI), Pittsburgh, PA. Eastern Field Operations.
For primary bibliographic entry see Field 5D.
W90-04418

SELECTION AND EVALUATION OF SITES FOR CONSTRUCTED WASTEWATER TREATMENT WETLANDS.
Tennessee Valley Authority, Chattanooga. Div. of Power System Operations.
For primary bibliographic entry see Field 5D.
W90-04419

PERFORMANCE EXPECTATIONS AND LOADING RATES FOR CONSTRUCTED WETLANDS.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04420

OVERVIEW FROM DUCKS UNLIMITED, INC.
Ducks Unlimited, Inc., Bismarck, ND. Great Plains Regional Office.
For primary bibliographic entry see Field 5D.
W90-04422

CONSIDERATIONS AND TECHNIQUES FOR VEGETATION ESTABLISHMENT IN CONSTRUCTED WETLANDS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5D.
W90-04427

PATHOGEN REMOVAL IN CONSTRUCTED WETLANDS.
San Diego State Univ., CA. Graduate School of Public Health.
For primary bibliographic entry see Field 5D.
W90-04429

NITRIFICATION AND DENITRIFICATION AT ISELIN MARSH/POND/MEADOW FACILITY.
Moon Township Municipal Authority, Coraopolis, PA.
For primary bibliographic entry see Field 5D.
W90-04433

POTENTIAL IMPORTANCE OF SULFATE REDUCTION PROCESSES IN WETLANDS CONSTRUCTED TO TREAT MINE DRAINAGE.
Bureau of Mines, Pittsburgh, PA.
For primary bibliographic entry see Field 5D.
W90-04437

EVALUATION OF SPECIFIC MICROBIOLOGICAL ASSAYS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT MANAGEMENT.
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5D.
W90-04438

SECONDARY TREATMENT OF DOMESTIC WASTEWATER USING FLOATING AND EMERGENT MACROPHYTES.
Reedy Creek Utilities Co., Inc., Lake Buena Vista, FL.
For primary bibliographic entry see Field 5D.
W90-04439

AMPLIFICATION OF TOTAL DRY MATTER, NITROGEN AND PHOSPHORUS REMOVAL FROM STANDS OF PHRAGMITES AUSTRALIS BY HARVESTING AND REHARVESTING REGENERATED SHOOTS.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5D.
W90-04440

DOMESTIC WASTEWATER TREATMENT USING EMERGENT PLANTS CULTURED IN GRAVEL AND PLASTIC SUBSTRATES.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5D.
W90-04441

AQUATIC PLANT CULTURE FOR WASTE TREATMENT AND RESOURCE RECOVERY.
National Fertilizer Development Center, Muscle Shoals, AL.
For primary bibliographic entry see Field 5D.
W90-04442

BACTERIOLOGICAL TESTS FROM THE CONSTRUCTED WETLAND OF THE BIG FIVE TUNNEL, IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 5D.
W90-04443

USE OF PERIPHYTON FOR NUTRIENT REMOVAL FROM WATERS.
Vyzkumny Ustav Vodohspodarsky, Prague (Czechoslovakia).
J. Vymazal.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 558-564, 3 fig, 1 tab, 1 ref.

Descriptors: *Nutrient removal, *Periphyton, *Wastewater treatment, *Wetlands, *Land disposal, *Biological wastewater treatment, Water pollution control, Artificial watercourses, Algae, Eutrophication, Nitrogen removal, Phosphorus removal, Biofilms, Ecology, Drinking water, Reservoirs.

Drinking water treatment difficulties presented by algal development in reservoirs can be prevented by lowering nutrient input into drinking water reservoirs. One possible intervention is to use naturally growing periphyton communities on artificial substrata to lower nutrient levels in reservoir tributaries. The efficacy of periphyton communities in nutrient elimination in a continuous-flow trough was evaluated in the field. The trough was wood and was 5 m long, 0.5 m wide, and 0.7 m deep. Silon (nylon) screens (50 x 50 cm, hole size about 1 sq mm) were placed in the troughs perpendicular to the direction of flow. River water was used, with a retention time of 4 hr in the trough. Flow was 312.5 L/hr (total volume of water in the trough was 1250 L). Two experiments were conducted, one to examine nutrient elimination with time, periphyton community growth, and composition, and another aimed at the time-course of nutrient elimination and composition of periphyton communities in the trough. The maximum values of elimination during the first field experiment were NO3(-), 24%; NH4+, 59%; and PO4(3-), 54%. The course of nitrate removal fluctuated greatly and was difficult to evaluate. Average influent concentrations were NO3(-), 14.1mg/L, NO2(-), 0.17 mg/L, NH4+, 2.65 mg/L; and PO4(3-), 1.35 mg/L. The course of nutrient removal during the second field experiment was similar to the first, but the maximum levels of NH4(+), and PO4(3-) elimination were much higher (almost 80% and 70%, respectively). Elimination of nitrates was at approximately the same level (22%). The average influent concentrations were similar to those in the first experiment. For practical applications, these results indicate that it is best to replace highly colonized screens promptly, allowing biofilm formation only for a limited period. Effluent community structure changed during the course of the experiment in response to a decrease in inorganic nutrients and organic content of the trough. The periphyton community growing on artificial substrata proved to be a useful means of nutrient removal from polluted waters. Periphyton growth could be used either in waterworks pretreatment, especially in small eutrophic tributaries to drinking water reservoirs, or in the tertiary treatment process. (See also W90-04392) (Rochester-PTT)
W90-04444

DANISH EXPERIENCE WITH SEWAGE TREATMENT IN CONSTRUCTED WETLANDS.
Aarhus Univ. (Denmark). Botanical Inst.
For primary bibliographic entry see Field 5D.
W90-04445

MAN-MADE WETLANDS FOR WASTEWATER TREATMENT: TWO CASE STUDIES.
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.
For primary bibliographic entry see Field 5D.
W90-04446

RESEARCH TO DEVELOP ENGINEERING GUIDELINES FOR IMPLEMENTATION OF CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT IN SOUTHERN AFRICA.
Steffen, Robertson and Kirsten, Inc., Johannesburg (South Africa).
For primary bibliographic entry see Field 5D.
W90-04447

WASTEWATER TREATMENT/DISPOSAL IN A COMBINED MARSH AND FOREST SYSTEM PROVIDES FOR WILDLIFE HABITAT AND RECREATIONAL USE.
James Engineering, Inc., El Cerrito, CA.
For primary bibliographic entry see Field 5D.
W90-04449

ROOT-ZONE SYSTEM: MANNERSDORF. NEW RESULTS.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtchaft.
For primary bibliographic entry see Field 5D.
W90-04450

CONSTRUCTED WETLANDS FOR SECONDARY TREATMENT.
Nolte (George S.) and Associates, Sacramento, CA.
For primary bibliographic entry see Field 5D.
W90-04451

USE OF ARTIFICIAL CATTAIL MARSHES TO TREAT SEWAGE IN NORTHERN ONTARIO, CANADA.
Hanna (J.E.) Associates, Inc., Pickering (Ontario).
For primary bibliographic entry see Field 5D.
W90-04453

SOME ANCILLARY BENEFITS OF A NATURAL LAND TREATMENT SYSTEM.
Grand Strand Water and Sewer Authority, Conway, SC.
For primary bibliographic entry see Field 5D.
W90-04454

WASTEWATER WETLANDS: USER FRIENDLY MOSQUITO HABITATS.
Marin Sonoma Mosquito Abatement District, Petaluma, CA.
For primary bibliographic entry see Field 5D.
W90-04457

DEVELOPMENT OF AN URBAN RUNOFF TREATMENT WETLANDS IN FREMONT, CALIFORNIA.
Bowling Green State Univ., OH. Environmental Health Program.
For primary bibliographic entry see Field 5D.
W90-04458

URBAN RUNOFF TREATMENT IN A FRESH/BRACKISH WATER MARSH IN FREMONT, CALIFORNIA.
Association of Bay Area Governments, Oakland, CA.
For primary bibliographic entry see Field 5D.
W90-04459

DESIGN OF WET DETENTION BASINS AND CONSTRUCTED WETLANDS FOR TREATMENT OF STORMWATER RUNOFF FROM A REGIONAL SHOPPING MALL IN MASSACHUSETTS.
IEP, Inc., Northborough, MA.
For primary bibliographic entry see Field 5D.
W90-04460

CREATION OF WETLANDS FOR THE IMPROVEMENT OF WATER QUALITY: A PROPOSAL FOR THE JOINT USE OF HIGHWAY RIGHT-OF-WAY.
Environmental Protection Agency, Annapolis, MD. Chesapeake Bay Liaison Office.
L. C. Linker.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 695-701, 1 fig, 2 tab, 5 ref.

Descriptors: *Land disposal, *Artificial wetlands, *Maryland, *Highways, *Land use, *Urban runoff, Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Performance evaluation, Nutrient removal, Cost analysis, Construction costs, Economic aspects, Phosphorus, Nitrogen, Biological oxygen demand, Heavy metals.

A proposal is described to incorporate public lands through joint use of highway right-of-way. The proposal identifies a potential highway site in Maryland for joint use as an engineered wetland to control urban nonpoint source (NPS) pollution from highly developed, established urban areas and provides preliminary analysis of the site's control effectiveness and design life costs. Several right-of-way sites within the Chesapeake Bay basin have been identified that (1) have large area and (2) intersect an urban stream. A portion of the Interstate 695 intersection with the Southeast Throughway and the Windlass Freeway in Middle River east of Baltimore was chosen as representative and calculations of pollutant removal efficiencies and pollutant removal costs were done. Removal efficiencies were predicted as follows: total P, 53%; total N, 41%; BOD5, 40%; Pb, 72%; Zn, 40%, and Cu, 40%. Based on the quantities of pollutants remove, a 50-yr design life, and estimates of routine and nonroutine maintenance, the estimated total cost, or net present cost, $1,420,000. Economies of scale, construction economies, and land acquisition economies make this the most cost-effective urban best management practice. Wetlands engineered to improve urban water quality on a basinwide scale also require large tracts of land. Objectives of transportation and water quality improvement may be compatible in many areas of highway right-of-way. Public benefits accrue from three aspects of a joint use program: (1) basinwide control provides considerable economies of scale in both construction and maintenance; (2) the 'cut and fill' structure of major interchanges provides appropriate topography for engineered wetland; and (3) joint use of public land avoids the social and economic expense of condemning private land to assemble a separate tract of land for NPS control. (See also W90-04392) (Rochester-PTT)
W90-04461

WETLANDS TREATMENT OF DAIRY ANIMAL WASTES IN IRISH DRUMLIN LANDSCAPE.
Lough Gara Farms Ltd., Boyle (Ireland).
For primary bibliographic entry see Field 5D.
W90-04462

POTENTIAL ROLE OF MARSH CREATION IN RESTORATION OF HYPERTROPHIC LAKES.
Saint Johns River Water Management District, Palatka, FL.
E. F. Lowe, D. L. Stites, and L. E. Battoe.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 710-717, 3 fig, 2 tab, 13 ref.

Descriptors: *Water pollution treatment, *Land disposal, *Florida, *Hypertrophic lakes, *Lake restoration, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Lake Apopka, Marshes, Aquatic habitats, Wildlife habitats, Agricultural runoff, Phosphorus, Nutrient removal, Design criteria.

A novel approach is proposed and an example is described of a plan for hypertrophic lakes. In a typical sewage treatment wetland, water high in inorganic nutrients passes through the system once, and the management goal is to maximize the nutrient removal efficiency. In the present application, water to be treated has high concentrations of nutrients associated with particles and dissolved organic molecules. Water is passed through the system many times rather than once. The goals of this approach are to maximize nutrient quantity removed per unit of time (power) and nutrient permanently stored (capacity) rather than nutrient fraction removed in single pass (efficiency). Lake Apopka, located in central Florida, is a large (124 sq km), shallow (mean depth 1.7 m) and hypertrophic lake (trophic state index 86), which has been the subject of a design study concerning construction of a 32 sq km wetland. The project has three main goals: (1) establishment and maintenance of a hydrologic regime and vegetation that maximizes the wetland's power and capacity for nutrient storage; (2) creation of a broad and persistent biological connection between the lake and the created marsh; and (3) establishment and maintenance of a diverse wetland habitat to support aquatic and wetland wildlife. Expected benefits include elimination of nearly 45% of the agricultural discharge to the lake, approximately 41% of the total annual loading of P and increased nutrient export from the lake because water flow will be into and through the wetland, with discharge to downstream lakes. (See also W90-04392) (Rochester-PTT)
W90-04463

NATURAL RENOVATION OF LEACHATE-DEGRADED GROUNDWATER IN EXCAVATED PONDS AT A REFUSE LANDFILL.
South Dakota State Univ., Brookings.
J. N. Dornbush.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 743-752, 4 fig, 3 tab, 8 ref.

Descriptors: *South Dakota, *Landfills, *Groundwater pollution, *Water pollution treatment, *Wastewater treatment, *Wetlands, Biological wastewater treatment, Water pollution control, Macrophytes, Performance evaluation, Design criteria, Hydraulic engineering, Monitoring, Arsenic, Water table fluctuations.

The solid waste landfill at Brookings, South Dakota, is typical of many landfills. Its location in an old gravel pit area over a groundwater aquifer with a shallow water table subjects the aquifer to contamination from precipitation-induced leachate from buried solid wastes. Groundwater contamination also may occur when the water table rises to contact the solids wastes. Unlike many other landfills, at the Brookings landfill a trench and wetland ponds have been installed to intercept, treat, and dilute the degraded groundwater. The primary significance of the trench and pond was that the leachate plume was destroyed. Data from 1965 to 1966 (before construction of the pond and trench) revealed that degraded water flowed in a clearly defined plume moving in the direction of groundwater flow. After construction of the pond and trench, similar data revealed that the well-defined plume was no longer present, and that downstream water quality was similar in most respect to that from control wells upstream. Monitoring with an extensive well network in the 1980s revealed that downstream from the landfill some pollutants were elevated, although arsenic was the only toxic metal that exceeded drinking water standards (6700 microgram/L). A 1987 Superfund study found that no release to groundwater was occurring because the trench was intercepting leachate. The trench at the Brookings landfill has protected shallow groundwater by several mechanisms, including dilution mixing, gas interchange, metal oxidation, and biological treatment. Land use on the site and in the surrounding areas has been changing. Approximately 90 new residences now use septic tanks that discharge to the aquifer through their drainfields. A 65-ha, center-pivot irrigation unit has been installed directly south of the disposal site; drawdown during heavy summer pumping may affect the direction of groundwater flow in the vicinity of the landfill. Recent evidence indicates that the water table may be rising. With continued landfill operation, a 10-m hill has been formed in the refuse disposal area and the trench has expanded into sizable wetland ponds. After the landfill closes in the 1990s, the hill, ponds, and wooded area will become features of a future nature park. (See also W90-04392) (Rochester-PTT)
W90-04467

BIOLOGY AND CHEMISTRY OF GENERATION, PREVENTION AND ABATEMENT OF ACID MINE DRAINAGE.
Silver (Marvin) Scientific Ltd., Bedford (Nova Scotia).
For primary bibliographic entry see Field 5B.
W90-04468

DETERMINING FEASIBILITY OF USING FOREST PRODUCTS OR ON-SITE MATERIALS IN THE TREATMENT OF ACID MINE DRAINAGE IN COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 5D.
W90-04471

USE OF WETLANDS TO REMOVE NICKEL AND COPPER FROM MINE DRAINAGE.
Minnesota Dept. of Natural Resources, St. Paul. Minerals Div.
For primary bibliographic entry see Field 5D.
W90-04472

WINDSOR COAL COMPANY WETLAND: AN OVERVIEW.
American Electric Power Corp., Lancaster, OH.
For primary bibliographic entry see Field 5D.
W90-04473

WETLAND TREATMENT OF COAL MINE DRAINAGE: CONTROLLED STUDIES OF IRON RETENTION IN MODEL WETLAND SYSTEMS.
Villanova Univ., PA. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-04474

TOLERANCE OF THREE WETLAND PLANT SPECIES TO ACID MINE DRAINAGE: A GREENHOUSE STUDY.
Pennsylvania State Univ., University Park. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W90-04475

OIL WATER SEPARATORS. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-04477

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA): HAZARDOUS WASTES. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-857270. Price codes: N01 in paper copy; N01 microfilm. Mar 89, 88p.

Descriptors: *Bibliographies, *Water law, *Resource Conservation and Recovery Act, *Hazardous wastes, Literature review, Landfills, Landfill linings, Incineration.

This bibliography contains 147 citations concerning the Resource Conservation and Recovery Act. Citations cover the handling of hazardous waste, facility investigation, and updates and reviews of selected provisions of the act. Groundwater monitoring, landfill design, liner systems, and incineration standards are among the topics discussed. The bibliography is fully indexed and includes a title list. (Author's abstract)
W90-04498

OIL SPILL REMOVAL: DISPERSANTS, ABSORBANTS, BOOMS, AND SKIMMERS. JANUARY 1978-JANUARY 1989 (CITATIONS FROM THE LIFE SCIENCES COLLECTION DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-855803. Price codes: N01 in paper copy; N01 microfilm. Supersedes PB86-856226. Prepared in cooperation with Cambridge Scientific Abstracts, Washington, DC. Feb 89. 105p.

Descriptors: *Bibliographies, *Oil pollution, *Oil spills, *Cleanup operations, Literature review, Dispersants, Case studies, Environmental impact.

This bibliography contains 198 citations concerning the techniques available for the removal of oil following major spills. Chemical dispersants, gelling agents, foam plastics, booms, skimmers, and burning are discussed. Specific oil spills are considered and the environmental impacts of oil spills are noted. Twenty of these citations are new entries to the previous edition. (Author's abstract)
W90-04503

EUTROPHICATION: WATER QUALITY AND POLLUTION CONTROL. JANUARY 1970-JANUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5C.
W90-04504

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

MANAGEMENT USE OF SCIENTIFIC INFORMATION.
National Oceanic and Atmospheric Administration, Rockville, MD. Ocean Assessments Div.
D. A. Wolfe.
IN: Environmental Studies in Port Valdez, Alaska: A Basis for Management. Lecture Notes on Coastal and Estuarine Studies Vol. 24, Springer-Verlag, New York, 1988. p 345-374, 2 fig, 2 tab, 36 ref.

Descriptors: *Management planning, *Regulations, *Valdez, *Alaska, *Site selection, Monitoring, Data acquisition, Environmental Policy Act, National Pollutant Discharge Elimination System, Pipelines, Alaska pipeline, Wastewater facilities.

The siting decision for the pipeline terminus and ballast water treatment facility at Port Valdez, Alaska, carried out in accord with National Environmental Policy Act (NEPA) requirements, involved an explicit comparison of alternatives with explicit identification of concern for potential impacts. The risk and hazard assessments were nonquantitative and few if any probabilistic analyses were performed with respect to environmental issues. The weighing and balancing of outcomes and alternatives were not documented for the terminal siting decision in any quantitative sense, and the results of monitoring (information gathering) during the development and post-development phases cannot be related back to the decision process. Given the regulatory framework under NEPA and National Pollutant Discharge Elimination System (NPDES) and the attendant problems, the use of scientific information appears to have been effective in the management of the Port Valdez environment. Available scientific information has generally been used in the application of the NPDES regulatory framework. Monitoring requirements have represented generally realistic management concerns and state-of-the-art approaches for addressing those concerns. A continuing danger in the design of monitoring requirements is the natural tendency to search for any and all possible indications of deleterious effects. Efficient (and economical) monitoring should focus on detection of specific, identified-in-advance outcomes of concern that would, if found, warrant corrective action. The level of effort should be dictated both by the severity of the outcome and by its probability of occurrence. Improved documentation of the overall decision process (outcomes of concern, alternative under consideration, information needs, application of study results, and conclusions reached) would serve to enhance public confidence in the management process and would also decrease the likelihood of repetitious and otherwise unnecessary studies and analyses over the long run. (See also W90-03610) (Lantz-PTT)
W90-03624

GEOMORPHOLOGIC CONTRIBUTIONS TO FLOOD CONTROL PLANNING.
Washington Univ., Seattle. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2E.
W90-03686

WATER RESOURCE MANAGEMENT: INTEGRATED POLICIES.
Organization for Economic Co-Operation and Development, Paris (France).
Organization for Economic Co-Operation and Development, Paris, France. 1989. 199p.

Descriptors: *Europe, *Water management, *Water resources management, *Policy making, Governmental interrelations, Public policy, Institutional constraints, Water demand, Groundwater management.

Water resources management is an important and complex area of governmental resource management and environmental policies. It includes the management of the quantity and quality of water used for all purposes, including drinking water, industrial water, irrigation and recreational uses and the various sources of supply, e.g. surface as well as groundwater. In addition, resource management policies have to be reconciled with environmental and other economic policies, including agricultural policies to ensure an overall economic efficiency in policy formulation and implementation. Water resource management policies should be designed to: correct the institutional failures which are present and which manifest themselves in fragmented, conflicting and uncoordinated management of the various aspects of water resources; correct market failures which, are manifested by nonexistent or partial and inefficient demand management of water resources; and correct management failures in the use and protection of groundwater resources. Therefore, water resources management is both an economic and environmental challenge and it needs to be resolved in an integrated manner to meet the environmental and economic requirements and to provide water at the appropriate quality at the lowest cost. The report indicates the main areas of concern which need to be resolved to move toward this goal. The report addresses these problem areas and is the result of a 3-year project during which Member countries of the Organization of Economic Co-Operation and Development made a major cooperative effort to pool their knowledge and experiences. (Lantz-PTT)
W90-03746

CONVIVIAL TECHNOLOGY AS A LOCAL APPROACH TO GROUND-WATER PROTECTION: THE CHRISTINA RIVER BASIN EXPERIENCE.
Pennsylvania Univ., Philadelphia. Center for Ecological Research.
For primary bibliographic entry see Field 5G.
W90-03787

CATCHMENT MANAGEMENT IN AUSTRALIA IN THE 1980S.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
P. Laut, and B. J. Taplin.
CSIRO Divisional Report 89/3, July 1989. 252 p.

Descriptors: *Water resources, *Water management, *Australia, *Catchment areas, Case studies, Lockyer Valley, Queensland, Hunter Valley, Macquarie-Bogan Catchment, New South Wales, Campaspe Catchment, Victoria, Onkaparinga Catchment, Mount Bold Reservoir, South Australia, Wellington Reservoir, Western Australia, Reservoirs, Reservoir operation.

This report, commissioned by the Surface Water and Catchment Committee of the Australian Water Resources Council for a workshop on catchment management, consists of two parts: an overview of catchment management as practiced in Australia in the 1980s and a discussion of future directions; and a set of six case studies of catchments which illustrate the variety of conditions, issues and management responses experienced by Australian catchment managers. The case study catchments include the Lockyer Valley in Queensland, the Hunter Valley and the Macquarie-Bogan catchment in N.S.W., the Campaspe catchment in Victoria, the Onkaparinga catchment above Mt. Bold Reservoir in South Australia, and the Wellington Reservoir catchment in Western Australia. Each case study contains information on the land and water resources of its catchment area, current catchment management issues, and current catchment management activities. (Lantz-PTT)
W90-03805

LIVING WITH THE LAKES: CHALLENGES AND OPPORTUNITIES.
International Joint Commission-United States and Canada, Windsor (Ontario).
A Progress Report to the International Joint Commission, July 1989. 108p, 16 fig, 3 tab, 12 append.

Descriptors: *International commissions, *Water resources management, *Great Lakes, *Management planning, St Lawrence River, Water level fluctuations, Decision making, Ecosystems, Data interpretation.

The Governments of Canada and the United States on August 1, 1986 asked the International Joint Commission 'to examine and report upon methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin'. This progress report is Phase I of the study, which consists of an Executive Summary, the Main Report, and seven subject-specific Annexes. Phase I identified the priority goals of developing a set of principles to guide decision-

making, a strategy that could result in coherent and effective government action and a methodology for evaluating measures for specific, local scenarios in a broad and systemic context. Work toward these goals has begun, producing the following: a preliminary mapping of interrelations among components of the natural and human systems; indications of the positions held by interests; and a coalescing sense of need for an overall strategy of governance. Parallel to this work possible measures have been catalogued and a methodology drafted for evaluating them in an orderly and organized manner. Phase I also concludes that measures, particularly combinations of measures, may have high potential for alleviating adverse consequences at specific locales. Discoveries concerning systemic context, ecological dynamism, public misunderstanding and governance impediments do not converge to rule out the potential utility and broad efficacy of solutions tailored to unique, local circumstances. The taxonomy of possible measures and the draft evaluation methodology relate impacts of fluctuations to generic interests and suggest groups of certain measures, thereby expanding understanding of the overall problem. (Lantz-PTT)
W90-03816

ANNUAL REPORT OF THE NATIONAL BOARD OF WATERS AND THE ENVIRONMENT FOR 1988. (VESI-JA YMPARISTOHALLINTO, TOIMINTA KERTOMUS 1988).
National Board of Waters, Helsinki (Finland).
1989. 44 p. (In Finnish).

Descriptors: *Water resources management, *Finland, Water resources, Water management, Precipitation, Water pollution control, Environmental protection, Personnel, Economic aspects, Flood control.

In 1988, the hydrological conditions in Finland were exceptional in many respects. The amount of snow was twice normal in southern and central Finland. Snowmelt and spring rains raised the water levels in spring and early summer to the highest of the century. The state of the water bodies remained unaltered. The potential yield of Finnish groundwater resources is estimated to be 4 million cu m/day. Public water works distributed water to about 4 million people. Half of this water was groundwater. Per capita use of water was 291 L/day. Main problems affecting the aquatic environment were eutrophication, acidification and single-purpose use of the water bodies, introduction and accumulation of toxic substances in the environment, impoverishment of the aquatic environment as well as a general slow deterioration in environmental quality. The planning programs of the Water and Environment Districts for 1988 included 126 projects for the restoration and recreational use of water bodies. Eleven plans serving flood control were completed. An area of 1500 ha, most of which is cultivated land, will benefit from these projects. 1988 was the first year in which the alarm system at the National Board of Waters and the Environment was fully operational. During the year, 43 alarms were made. However, no major oil spills occurred. Emphasis in research was on monitoring of the quantity and state of water resources, groundwaters, impurities in air, the impacts of other nonpoint source pollution, waste management and chemicals. At the end of 1988 the staff of the central agency numbered 437 and that of the district organization 1190. In addition, 813 persons were employed at the working sites in the Water and Environment Districts. The appropriations in this administrative sector were 540 million marks, of which 150 million marks were used in other agencies. (Lantz-PTT)
W90-03817

INTERFACING NONPOINT SOURCE PROGRAMS WITH THE CONSERVATION RESERVE: GUIDANCE FOR WATER QUALITY MANAGERS.
North Carolina State Univ. at Raleigh.
For primary bibliographic entry see Field 5G.
W90-03848

VALUE OF STREAMFLOW FORECASTING IN RESERVOIR OPERATION.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-04176

OVERVIEW OF THE RECONNAISSANCE-FEASIBILITY STUDY AND PLANNING PROCESS-PROGRAM.
Corps of Engineers, Washington, DC.
J. D. Davidson, and W. V. Paynes.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 1-10, 2 fig.

Descriptors: *Nonstructural alternatives, *Management planning, *Economic aspects, *Water resources management, Decision making, Flood damage, Feasibility studies.

The last significant change in the water resources planning process and program occurred in the 1970s, as a result of the increased focus on the environment. With enactment of the Water Resources Development Act of 1986 (WRDA '86) certain changes were mandated, others were permitted, and others are deemed necessary as a result of various other provisions within the Act. The Act required more cost sharing by non-Federal interests and placed statutory time limits and cost sharing requirements on the U.S. Army Corps of Engineers planning. This paper provides an overview of the current planning process and program, and highlight changes that have occurred since enactment of WRDA '86. Enactment of the WRDA '86 presented opportunities that have allowed the Corps to move toward the 'no gap implementation model.' As a result of initiatives implemented since WRDA '86 a project development process is now in place that will ready a project for construction in an estimated 8 years. Some of the initiatives implemented were: (1) early involvement in the planning process by the Office of the Assistant Secretary of the Army for Civil Works (OASA(CW)) and the Headquarters, U.S. Army Corps of Engineers (HQUSACE) to insure early and effective resolution of policy issues; (2) a concurrent and consolidated Washington level review process for the feasibility report; (3) programming funds to initiate detailed project design upon issuance of the division engineers notice; (4) permitting local cooperation agreements to be finalized and ready for execution once the project has been selected as a new construction sort; and (5) intensively monitoring costs and schedules through a life cycle project management system in the planning, design and construction phases. The reconnaissance phase results in the first decision document. It forms the basis for initial non-Federal commitment of funds, further commitment of Federal funds, and establishes the management structure, schedule and cost for conduct of the feasibility study. One of the most important concepts recently incorporated in the feasibility planning process is early Washington level involvement and agency commitment. (See also W90-04234) (Lantz-PTT)
W90-04235

PLAN FORMULATION STRATEGY--KAWEAH CASE STUDY.
Army Engineer District, Sacramento, CA. Special Studies Branch.
For primary bibliographic entry see Field 6F.
W90-04242

STUDY MANAGEMENT BLUE RIVER BASIN CASE STUDY.
For primary bibliographic entry see Field 6F.
W90-04243

SAPHO20: AN AID IN WATER PLANNING(SAPHO20: SYSTEME D'AIDE A LA PLANIFICATION DE L'EAU).
Grenoble-2 Univ. (France). Centre de Recherche en Informatique Appliquee aux Science Sociales.
R. Arrus.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 209-224, 1 fig, 8 ref. English summary.

Descriptors: *Computer programs, *Computer-aided engineering, *Planning, *Regional development, *Project planning, *Model studies, *Computer programs, *Water resources development, *Semiarid lands, Water demand, Industrial water, Municipal water, Mediterranean Basin, SAPHO20.

SAPHO20 represents an attempt to provide a solution to problems encountered in the study of the economic development of the semi-arid zone of the Mediterranean basin, especially when the role of water is to be analyzed in connection with overall economic and social development. The object is to provide an expert system which would give support in the diagnosis and correction of problems arising in planning for the utilization of hydrologic resources. The model can consider such problems as soil erosion, bank protection, urban water demand, and industrial water demand. SAPHO20 is an interactive system which the user addresses in natural language. The system would aid in the development of treatments which are the best adjusted according to criteria chosen by the user and would signal the eventually incongruities between the observed criteria and the development scenario chosen. (See also W90-04274) (Peters-PTT)
W90-04289

COMPUTER AIDED MANAGEMENT OF WATER RESOURCES SYSTEMS.
Politechnika Warszawska (Poland). Inst. of Environmental Engineering.
W. Sikorski, and K. Krajewski.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 225-232, 4 fig, 11 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Computers, *Mathematical models, *Water resources development, *Poland, Optimization, Simulation, Forecasting, Data processing.

Computer-aided management is one of the most important trends in the modern approach to the problems of the management of water resources. There are several optimization, simulation and forecasting models being created for water systems. It is important to structure the models for easy application by the manager of the system. Computer-aided management may include running existing models, displaying the data on the performance system, on-line control, and analysis of decision making. All elements can be run as separate programs or may form an integrated system supervised by a control program. The creation of a control system in an agricultural region of central Poland illustrates the implementation of computer-aided management in countries which have problems with equipment and with the education of the management staff. Menus were created in the simplest possible format to help the system manager to select the appropriate action. There is no database yet; the full database will be developed after gaining some experience with the performance of the models. The system is being implemented on IBM PC compatible equipment. (See also W90-04274) (Hammond-PTT)
W90-04290

DECISION MAKING AND THE COST OF IGNORANCE.
Engineering Decision Analysis Co., Inc., Palo Alto, CA.
J. R. Benjamin.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 76-83, 5 fig, 4 ref.

Descriptors: *Flood forecasting, *Forecasting, *Decision making, Statistical methods, Flood peak, Water management.

Decision theory is discussed with a brief introduction to the associated information theory. No large water-related engineering project has had a complete development or analysis consistent with decision theory. This does not mean that the decisions in such projects were wrong, only that the decision-making phenomenon in these large engineering projects differed from the methodology of the science of decision theory. Reasons for such differences are partly the unresolved issues of the value of human life, legal liability, the natures of the legal and political processes, and the like. Thus this paper is concerned with a methodology that may or may not directly apply to the economic aspects of hydrologic forecasting. A decision tree illustrates the components of decision theory and their relationships. First, there is assumed to be a decision maker labeled DM. This DM must choose between possible actions or alternatives labeled AA, BB, CC. Having chosen one of the possible actions, the DM faces the uncertain future, SS, MM, FF. The DM will receive value depending on the action chosen and the future that is received. This value is labeled U for utility. The problem of the DM is to make the optimum decision (choice of actions) considering that the future is uncertain with the goal of receiving the greatest value or utility. The identification of the optimal action is made by using a decision rule. Two examples illustrate simple applications of this decision tree. A Bayesian forecasting technique, which differs from the conventional statistics through its use of actuarial flow data and plotting procedures, is presented to give another approach for decision making. The Bayesian method points out that statistical decision methodology can be used as an additional tool in forecasting problems. Good Bayesian forecasters could even make a rational approach to the return period of the flow since subjective probabilities are an integral part of the methodology. (See also W90-04308)(Lantz-PTT)
W90-04313

HYDROLOGIC UNCERTAINTY AND PROJECT BENEFITS.
Bureau of Reclamation, Sacramento, CA. Mid-Pacific Regional Office.
For primary bibliographic entry see Field 7C.
W90-04314

PLANNING FOR USER ORIENTED HYDROLOGIC FORECASTS.
Utah Water Research Lab., Logan.
L. D. James.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 101-116, 22 ref.

Descriptors: *Forecasting, *Hydrology, *Water management, *Management planning, Water users, Community development.

The supply and demand approach to defining the need for improved forecasting must answer the question--who will receive and use the forecasts. Satisfying user demand requires a product designed to maximize user satisfaction. This approach to planning user-oriented hydrologic forecasts begins by identifying user characteristics that determine forecasting needs. The four dimensions of user perspective are taken as: (1) range of actions, (2) scope of control, (3) favored values, and (4) time frame. Each perspective is explored through definition of its distinctive characteristics, discussion of recent trends in the institutionalization of dealing with it, description of the sorts of forecasting information needed, and evaluation of the implications of the above for making forecasting improvements. This analysis can be best summarized in two recommendations each on what practices would seem likely to improve response and, perhaps more useful, what practices that ostensibly would seem to promote improvement should be used with caution because they are likely to be counter productive. The two recommendations on how not to improve are: (1) avoid the conceptual trap of thinking in terms of establishing a uniform system of forecasting and information dissemination. Deal with each situation as unique because it is; (2) do not assume that individuals are going to necessarily be eager to follow community values. They need to be motivated in terms of their own values. The two recommendations on how to foster improvement are: (1) develop a strong base of data on how people with the various dimensions of perception respond to alternative hydrologic information and delivery systems. Such data provide important information for research and evaluation; and (2) work with potential users in expanding their range of actions, increasing their scope of control, and showing them how hydrologic forecasts can be used to further their personal values. (See also W90-04308)(Lantz-PTT)
W90-04315

MYTHS AND USES OF HYDROMETEOROLOGY IN FORECASTING.
Miami Univ., Oxford, OH. Inst. of Environmental Sciences.
G. E. Willeke.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 117-124, 8 ref.

Descriptors: *Hydrometeorology, *Forecasting, *Water resources management, Statistical analysis, Probability distribution, Weather forecasting, Weather patterns.

It is important to distinguish between two situations in which hydrometeorological analysis may be used. The first is as an aid to decision making, the usual decision pertaining to the sizing of spillways, outlet works, downstream channel capacity, reservoir freeboard, etc. The other is as a tool in representing reality. There is significant overlap between the two situations. However, there is difference in that a decision maker may accept the reality of an event while denying its relevance or significance to the decision. Four myths about the uses of hydrometeorology are discussed in this paper: (1) the myth of the tails--statistical distributions applied to hydrometeorological events that fit through the range of observed data are applicable in the tails; (2) the myth of infinitesimal probability--the probability of occurrence of probable maximum (or minimum) events is infinitesimal; (3) the myth of impossibility--hydrometeorological estimates of extreme events are so large that they cannot or will not occur; and (4) the myth of stationarity--the distribution of events is not changing in a trend, cyclic, persistent, or catastrophic fashion. The potential uses of hydrometeorology are more numerous than for simply determining the potential magnitude of the rarest floods. The most likely new use is at the opposite end of the spectrum, the extreme drought. Essentially the same principles used in flood estimation can be used in droughts: transposition, envelopment, and moisture optimization. (See also W90-04308)(Lantz-PTT)
W90-04316

APPLICABILITY OF SPACE ACQUIRED DATA FOR WATER RESOURCES MANAGEMENT.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
For primary bibliographic entry see Field 7B.
W90-04317

HYDROCLIMATOLOGY--A NEEDED CROSS-DISCIPLINE.
International Engineering Co., Inc., San Francisco, CA.
For primary bibliographic entry see Field 2B.
W90-04319

CALIFORNIA DROUGHT--ITS EFFECT ON RUNOFF FORECASTING FOR POWER GENERATION.
Pacific Gas and Electric Co., San Francisco, CA.
For primary bibliographic entry see Field 2E.
W90-04324

BPA HYDROLOGIC FORECASTING CONSIDERATIONS AND ACTIONS DURING THE 1976-77 DROUGHT.
Bonneville Power Administration, Vancouver, WA. Hydrometeorology Section.
For primary bibliographic entry see Field 7C.
W90-04325

WATER SUPPLY FORECASTING IN CALIFORNIA--1976-78.
California State Dept. of Water Resources, Sacramento. Snow Surveys Branch.
For primary bibliographic entry see Field 7B.
W90-04326

FLOOD PLAIN MANAGEMENT NEEDS.
Office of the Chief of Engineers (Army), Washington, DC. Flood Plain Management Services Branch.
For primary bibliographic entry see Field 2E.
W90-04330

ATTITUDE, GUIDELINES, AND TECHNOLOGY IN PLAN FORMULATION.
Hydrologic Engineering Center, Davis, CA.
W. K. Johnson.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 342-351, 7 fig, 4 ref.

Descriptors: *Management planning, *Flood plain management, Decision making, Data interpretation, Public opinion, Standards.

Principles, standards, procedures, and regulations are an integral part of our planning process, supported by technology which allows us to quantify and analyze nearly any aspect of a planning study. It is thought that meeting principles, standards and various other guidelines is the objective of plan formulation; that using a sophisticated technology in formulating plans is the objective. It is neither--it is meeting human needs. This is a discussion of this misunderstanding as applied to flood plain management. Through an analysis of: attitudes toward flood plain management; guidelines and needs; technology to accomplish these needs; data stored; and analysis of data. An exceedingly detailed and sophisticated technology has been developed to assist in plan formulation. Guidelines on how to conduct and what to include in the planning process are also available. However, neither are sufficient in themselves to support a flood plain management plan. A plan can only be supported because it meets human needs. The task of plan formulation is to develop such a plan. More important than technology or guidelines is an attitude and desire which strives incessantly, in spite of numerous obstacles, to develop this support. (See also W90-04398) (Lantz-PTT)
W90-04332

HYDROLOGY AND ENVIRONMENTAL ASSESSMENTS.
EMANCO, Inc., Houston, TX.
For primary bibliographic entry see Field 7B.
W90-04335

SECTION 208 PLANNING PROCESS--THE FEDERAL VIEW.
Environmental Protection Agency, Washington, DC. Water Planning Div.
For primary bibliographic entry see Field 6E.
W90-04339

STATE ASPECTS OF 208 PLANNING.
Virginia State Water Control Board, Richmond. Bureau of Water Control Management.

Group 6A—Techniques Of Planning

For primary bibliographic entry see Field 6E.
W90-04340

EXPERIENCES AND PERCEPTIONS OF THE 208 PROGRAM AT THE SUBSTATE LEVEL.
Middlesex County Planning Board, New Brunswick, NJ.
D. S. Powell.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 24-38.

Descriptors: *Urban hydrology, *Water pollution control, *Water quality management, *Local governments, *Political aspects, *New Jersey, Water quality, State jurisdiction, Storm runoff, Urban runoff, Federal jurisdiction, Policy making.

The water quality management planning process, as stated in Section 208 of the Water Pollution Control Act of 1972 is well conceived for decision making at the substate level. While the 2-year time scale set by the designers is unrealistic for the monumental tasks of technical analysis and political interaction implied by the law and its regulations, the concepts are sound and appropriate to democratic local decision making ideals. The nature of New Jersey's urbanizing and industrializing region (of New Jersey) brought peculiarly intense pollution problems; it is one of the nation's major chemical and petrochemical industrial complexes, a growing petroleum refining hub, and a center of primary metals manufacturing. To resolve these problems, sub-basin decision making is essential. However, the deeper one gets into the 208 experience, the more it was perceived to be as much a political as a technical process. It was also found that in the sub-state area, 208 planning must embrace and integrate as full a range as possible of water handling concerns: water quality, water supply and storm drainage/flood control. Distrust that pervaded relations among and between officials and participants in the water quality planning efforts at the Federal, state and local levels was a major perception that emerged from the New Jersey sub-state experience of the 208 process. Another perception derived from the sub-state experience concerns the relationship of land use and water quality planning. The management and administering of 208 at the Federal and state levels appears top heavy with technically oriented people and especially lawyers with too thin an experience at the local level. A major step to redress this imbalance will be to bring into all administrative levels program people with broad general local governmental and political experience. (See also W90-04338)(Lantz-PTT)
W90-04341

NATIONAL WATER POLICY.
Library of Congress, Washington, DC. Congressional Research Service.
W. Viessman.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 39-46.

Descriptors: *Urban hydrology, *Water pollution control, *Federal jurisdiction, *Water policy, *Water resources management, Policy making, Water conservation, Public policy, Environmental protection.

On June 6, 1978, President Carter presented his Federal Water Policy Initiatives (WPI) to the Congress. They were to: (1) improve planning and efficient management of Federal water resources programs; (2) provide a new, national emphasis on water conservation; (3) enhance Federal-State cooperation; and (4) increase attention to environmental quality. The WPI contained positive recommendations on: conservation; cost-sharing; planning procedures; and environmental protection but many controversial subjects were avoided and several important issues were given only a cursory treatment. Of particular importance is the fact that the water quality/water quantity interface was not considered, nor was there any proposal relative to the Federal water pollution control program with its massive outlays for capital construction. The President's Water Policy Initiatives contain needed improvements in cost-sharing policies and a strengthening of environmental consideration in water resources development. The Water Resources Council was directed to improve the Principles and Standards and to establish conservation as a principal component of the national economic development and environmental quality objectives of water resources planning. Many politically sensitive issues were side-stepped, however, and several topics were presented in generalities with no substantive remedial action proposed. The WPI contains no recommendations on water quality, research, or planning coordination. (See also W90-04338)(Lantz-PTT)
W90-04342

STRATEGIES TO OBTAIN WATER QUALITY CONSISTENT WITH OTHER OBJECTIVES.
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 5G.
W90-04344

WATER QUALITY MANAGEMENT ALTERNATIVES.
Miami Univ., Oxford, OH. Inst. of Environmental Sciences.
G. E. Willeke.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 168-176.

Descriptors: *Urban hydrology, *Water pollution control, *Water quality management, *Management planning, Governmental interrelations, Legal aspects, Federal jurisdiction, State jurisdiction, Best management practice, Water quality.

The relative merits of the following method for the management of water quality are compared: (1) Federal and State laws and regulations versus financial incentives; (2) specific planning versus broadly specified best management practices; and (3) regional groupings of counties and municipalities versus river basin authorities and other forms of organization. While financial incentives are popular in the management of water quality, particularly in relationship to Federal funds, laws and regulations remain the strongest and least erratic incentives. Although financial incentives often promote expenditures and help stimulate local economies, their focus is on equity, rather than efficiency. These incentives would be much more effective if they approximated the interest of the granting party (for example, 1/3 rather than 3/4 Federal share) and strings were attached which reflected these interests. For situations as large and complex as the management of water quality, specific planning offers appreciable advantages over broadly specified best management practices. If the expertise were always available at the local level, it would be the desired approach throughout the country. Best management practices are only applicable to cases in which the problems are small and the solutions are simple. In the area of management of water quality, there is no preferred organizational form. While regional groupings make good sense from both planning and management standpoints, not many Councils of Governments and Regional Commissions have established the credibility to take full responsibility in these areas. An underlying issue seems to be that local government officials, and their State and Federal counterparts, have little real interest in efficiency. They are primarily concerned with less tangible but more socially important issues of service, equity, and adequacy. (See also W90-04338)(Lantz-PTT)
W90-04357

SCIENCE, LAW, AND HUDSON RIVER POWER PLANTS: A CASE STUDY IN ENVIRONMENTAL IMPACT ASSESSMENT.
For primary bibliographic entry see Field 6G.
W90-04505

WHAT WE LEARNED ABOUT THE HUDSON RIVER: JOURNEY TOWARD AN ELUSIVE DESTINATION.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
R. J. Klauda, L. W. Barnthouse, and D. S. Vaughan.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 316-328. 90 ref.

Descriptors: *Thermal powerplants, *Nuclear powerplants, *Hudson River Estuary, *Environmental effects, *Environmental policy, *Estuarine fisheries, Legal aspects, Public policy, Mitigation, Environmental impact.

The major findings of the Hudson River power plant studies, a landmark environmental impact assessment conducted during the 1960s and 1970s, are summarized. The studies focused on the effects of power plant operations on finfish populations and contributed knowledge on: (a) the biology of Hudson River fishes; (b) sampling design and collection procedures; (c) measurement of entrainment and impingement mortality; (d) quantitative estimates of year-class strength reductions attributable to entrainment and impingement; (e) mitigation techniques; and (f) resolution of technical controversy in the face of uncertainty and an ineffective litigative process. Many insights contributed by the studies became the technical tools used to forge a negotiated settlement agreement in December 1980. The agreement ended the long-standing dispute among the utilities, regulatory agencies, and environmental groups regarding plans for a pumped-storage facility at Storm King Mountain and the need for cooling towers at several operating steam electric stations. These insights also provide a framework for research and monitoring tasks that have continued. In spite of its failure to achieve all study objectives, the Hudson River studies found acceptable solutions to the major environmental problems posed by power plants along the river. (See also W90-04505) (Author's abstract)
W90-04528

6B. Evaluation Process

CROP WATER USE.
Delta Branch Experiment Station, Stoneville, MS.
For primary bibliographic entry see Field 3F.
W90-03710

WATER RESOURCES MANAGEMENT PLAN, JACKSON COUNTY, MS.
Waggoner Engineering, Inc., Jackson, MS.
J. A. Waggoner, and C. H. Williford.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 17-26. 6 fig, 10 ref.

Descriptors: *Water resources management, *Management planning, *Mississippi, *Water management, *Water demand, *Water supply, *Potable water, *Water costs, Economic aspects, Costs, Long-term planning, Comprehensive planning, Water districts.

A comprehensive water resources evaluation and management plan has been prepared for Jackson County, Mississippi. The evaluation indicated that existing groundwater supplies are not adequate to meet the economic development needs of the county. Analyses found the Pascagoula River to be the best long-term alternate source of supply for serving the public and industrial water supply needs of the county. Evaluation of several alternatives found that installation of a county-wide potable water supply system would be the most cost-effective and implementable water management option. Estimates indicated that the program cost would range from 67-95 million dollars, depending on the level of industrial water usage on the system. Financial analyses indicated a probable unit wholesale cost to the user communities in the range of 40 cents to one dollar and twenty cents/

1,000 gallons, depending on the level of industrial usage, special sales tax income and sinking fund development. The management concept considered involved formation of a water management district to construct, operate and maintain the proposed facilities, and to provide water to the user communities based on contractual agreements. (See also W90-03708) (Author's abstract)
W90-03712

ANNUAL REPORT 1988.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
For primary bibliographic entry see Field 3F.
W90-03806

PAST DEVELOPMENTS IN PIPE DRAINAGE AND ITS FUTURE PROSPECTS.
For primary bibliographic entry see Field 3F.
W90-03807

WATER AND URBAN LAND-USE PLANNING IN CALI, COLOMBIA.
Hawaii Univ. at Manoa, Honolulu. Dept. of Geography.
For primary bibliographic entry see Field 6D.
W90-03977

RECONCILING PUBLIC OPINION AND WATER QUALITY CRITERIA IN SOUTH AFRICA.
Cape Town City Council (South Africa). City Planner's Dept.
For primary bibliographic entry see Field 5G.
W90-03990

CONFLICT ANALYSIS AND MANAGEMENT ALTERNATIVE FOR THE MANAYUNK CANAL.
Villanova Univ., PA. Dept. of Civil Engineering.
R. A. Chadderton.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1041-1046, October 1989. 1 tab, 15 ref.

Descriptors: *Pennsylvania, *Water resources development, *Water resources management, Hydroelectric power, Recreation demand, Manayunk Canal, Economic aspects.

The solution of a water resource allocation problem by an alternative social arrangement is presented. Classical Austrian economic theory and the 'new resources economics' provide both theoretical and practical evidence to support the development of well-defined, private property rights to the water resource in question. A method of conflict analysis, based on metagame theory, indicated that five possible equilibria could resolve the conflicts over use of the Manayunk Canal. The equilibrium outcome that most represented an average of acceptability by all parties also represented a compromise in usage of the canal resources. Management by a firm was suggested as an appropriate social arrangement to maximize net social benefits obtained from the canal resources. Economic calculations indicated that partial use of canal water to generate hydropower would not be profitable; more complete usage would be required. The addition of recreational development to the hydropower scenario would increase net benefits. The firm would maximize its 'profit' by generating full hydropower capacity and accommodating recreational development. Thus, as the firm acts to maximize 'profit' it also would maximize 'net social benefits.'(Author's abstract)
W90-04209

HUMAN PERCEPTION OF UTILIZATION OF WETLANDS FOR WASTE ASSIMILATION, OR HOW DO YOU MAKE A SILK PURSE OUT OF A SOW'S EAR.
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
R. C. Smardon.
IN: Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Lewis Publishers, Chelsea, Michigan. 1989. p 287-295, 1 fig, 1 tab, 18 ref.

Descriptors: *Public relations, *Wastewater treatment, *Land disposal, *Public opinion, *Wetlands, *Value, Biological wastewater treatment, Water pollution control, Artificial wetlands, Macrophytes, History, Illinois, Des Plaines River Demonstration Project.

Two aspects of the use of wetlands for waste assimilation are reviewed (1) the human perception of wetlands from a historical perspective and (2) how people perceive environmental quality in relation to odor, water quality, and wetland quality and a data gathering framework is outlined for assessing public perceptions on the role of wetlands in water quality enhancement. The problems associated with changing the perceived sow's ear of wetlands into a perceived silk purse are formidable. Historic values and perceptions of wetlands have been predominantly negative. Recent emphasis on ecological values and multifunctional aspects have 'cleaned up' the image of wetlands, but loading wetlands with wastewater could revive the negative imagery. Too little is known of the human perception of environmental quality parameters of wetlands, particularly odor, water quality, and health risk. Perceived environmental quality is related to wetland use, which outlines a framework for determining public perceptions and enlisting public support for wetlands wastewater treatment projects. Steps to be taken include: (1) understand public perception of (a) specific areas to be used for wetlands wastewater treatment and (b) using wetlands for wastewater treatment; (2) collect physical site user data and determine whether wetland site(s) restrict or enhance usage; (3) design interpretation/communication packages explaining the process of wastewater treatment with wetlands, including testing and retesting to assess changes in attitudes or perception; and (4) incorporate information gained in design, operation, and management of wetlands wastewater treatment projects. This strategy has been successful so far in the Des Plaines River Wetlands Demonstration Project (Illinois) and is likely to enhance public acceptance and support for other wetland restoration programs as well as constructed wetlands used for wastewater treatment. (See also W90-04392) (Rochester-PTT)
W90-04417

ANCILLARY BENEFITS OF WETLANDS CONSTRUCTED PRIMARILY FOR WASTEWATER TREATMENT.
Western Illinois Univ., Macomb. Inst. for Environmental Management.
For primary bibliographic entry see Field 5D.
W90-04421

OPTIMAL CAPACITY EXPANSION OF A WATER RESOURCE SYSTEM AND ISSUES OF WATER ALLOCATION AND USE: UMATILLA RIVER BASIN, OREGON.
Oregon State Univ., Corvallis. Water Resources Research Inst.
For primary bibliographic entry see Field 6D.
W90-04490

HUDSON RIVER SETTLEMENT AGREEMENT: TECHNICAL RATIONALE AND COST CONSIDERATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. W. Barnthouse, J. Boreman, T. L. Englert, W. L. Kirk, and E. G. Horn.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 267-273. 3 tab, 20 ref.

Descriptors: *Thermal powerplants, *Nuclear powerplants, *Hudson River Estuary, *Water resources management, *Environmental effects, Cooling towers, Legal aspects, Mitigation measures, Estuarine fisheries, Settlement agreements, Costs.

In an effort to end litigation over open-cycle cooling at Hudson River power plants, out-of-court negotiations began in August 1979. On December 19, 1980, an agreement that was acceptable to all parties was reached. As an alternative to building cooling towers at the Indian Point, Bowline Point, and Roseton generating stations, the utilities agreed to a variety of technical and operational changes intended to reduce entrainment and impingement. In addition, they agreed to supplement the production of striped bass in the Hudson River estuary by means of a hatchery, to conduct a biological monitoring program, and to fund an independent research foundation for study of Hudson River environmental problems. Although the settlement costs were substantial, they were much smaller than the estimated costs of constructing and operating cooling towers. The settlement was expected to provide 15-43% (depending on species) of the impact reduction that might have been obtained with cooling at approximately 10% of the cost. (See also W90-04505) (Author's abstract)
W90-04524

WHAT WE DIDN'T LEARN ABOUT THE HUDSON RIVER, WHY, AND WHAT IT MEANS FOR ENVIRONMENTAL ASSESSMENT.
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. W. Barnthouse, R. J. Klauda, and D. S. Vaughan.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 329-335. 44 ref. U.S. Department of Energy Contract DE-AC05-84OR21400.

Descriptors: *Thermal powerplants, *Nuclear powerplants, *Hudson River Estuary, *Environmental policy, *Water resources management, *Environmental effects, Environmental impact statement, Legal aspects, Estuarine fisheries.

Many of the major objectives of utility-sponsored and agency-sponsored Hudson River research programs were not achieved. Among these were identification and quantification of regulatory mechanisms and discovery of factors controlling year-class strength in striped bass and other important fish populations. Questions about community-level and ecosystem-level effects were not seriously addressed. Because of these limitations, an unambiguous assessment of the effects of power plants on the long-term production and persistence of Hudson River fish populations was not possible. It is argued that the failure to reach a scientifically defensible 'bottom line' was largely due to: (1) institutional constraints on the design and conduct of assessment studies; (2) the complexity and spatiotemporal variability of estuarine ecosystems; and (3) the inadequacy of existing population and ecosystem theory. It is concluded that, for the foreseeable future, estimates of short-term impacts on populations will continue to be the most useful indices of power plant effects. Long-term monitoring and basic research on ecological processes in estuaries, funded and managed independently of the regulatory process, are essential to improving future environmental impact assessments. (See also W90-04505) (Author's abstract)
W90-04529

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ARTHUR YOUNG GUIDE TO WATER AND WASTEWATER FINANCE AND PRICING.
Young (Arthur) and Co., Charlotte, NC.
G. A. Raftelis.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 220 p.

Descriptors: *Water systems, *Water rates, *Financing, *Pricing, *Wastewater facilities, *Utilities, Prices, Economic aspects, Management planning, Bond issues, Costs.

One of a water and wastewater utility's major objectives is to provide service at the most afford-

able price. At the same time, the utility must see that it complies with appropriate government regulations and that adequate funds are raised to maintain the utility on a financially self-sufficient basis. The book is organized into two parts. Part I (Chapters 2 through 6) deals with the financial planning challenges of a utility. Specifically discussed is an appropriate process for developing a financial plan with effective financing vehicles. Chapter 2 provides an overview of this process and discusses major components of the process. Chapter 3 discusses short-term financing techniques such as fixed rate demand notes, tax-exempt commercial paper, and variable rate demand notes. Also discussed in Chapter 3 are credit facilities for short-term financing and long-term financing methods such as general obligation bonds, revenue bonds, and double-barrel bonds. Chapter 4 elaborates on capital recovery charges, an increasingly popular source of revenue related to capital facilities. In Chapter 5, the concept of privatization as a method of financing capital facilities is discussed. Chapter 6 recommends a process for selecting an appropriate financial plan, considering such factors as short-term and long-term interest rates, costs and time frames of long-term issuance, risks associated with changing market conditions, the degree of public acceptance of the financing program, potential tax law changes, debt capacity, and timing of capital improvements. Part II of the book deals with water and wastewater pricing. In Chapter 7, an overview of the three-step cost determination and rate setting process is presented, with subsequent chapters dealing with each step of the process. Establishing water and wastewater revenue requirements is discussed in Chapter 8. Chapter 9 deals with allocating revenue requirements to various cost components and classes of water and wastewater customers. In Chapter 10, rate design is discussed. Chapter 11 discusses rate-setting trends across the country and presents the results of the 1988 Water and Wastewater Rate Survey. (Lantz-PTT)
W90-03810

FUNDING WASTEWATER PROJECTS WITH IMPACT FEES.
Camp, Dresser and McKee, Inc., Edison, NJ.
T. C. Schlette.
Water Environment and Technology, Vol. 1, No. 3, p 412-417, November 1989.

Descriptors: *Wastewater facilities, *Financing, *Impact fees, Economic aspects, Legal aspects, Case studies, Real estate development, Capacity charges, Developer fees, Municipal wastewater.

To mitigate the cost burden on existing users of providing new wastewater projects to keep up with residential and commercial development, municipalities have begun to use impact fees (also known as developer fees or capacity charges). Impact fees are designed to reflect a proportional relationship between costs and benefits, provide a clear price signal to those entities responsible for the increased demand, and create an effective mechanism for reducing the residual costs (taxes or user charges) of capacity expansion. Frequently, impact fees are used for large centralized facilities, but they may be used for off-site road improvements, parks, and affordable housing. The 'linkage' used to justify the latter expenditures is not always easy to establish. Impact fees and their legal ramifications are discussed, including: making fees equitable, use of impact fees as a fiscal management tool rather than a growth control tool, significant court cases concerning impact fees, fee design and alternative methodologies, implementation of an impact fee, and a hypothetical case study. In the case study, it is estimated that average sewer charges for all users would have to be $150/yr, which would represent a 50% increase for existing users. In contrast, if the municipality were to charge a $2,000 impact fee on all new developments, user charges would be reduced, and the costs of new facilities would be passed on to the new users. By funding the expansion in this way, debt service fees could be eliminated, thus reducing the overall cost per new user by $50/yr for 20 yr. Through proper application of impact fees in conjunction with other financial mechanisms, a more equitable system of cost recovery is attainable. (Rochester-PTT)
W90-03955

MAKING THE STATE REVOLVING FUND WORK: THE TENNESSEE EXPERIENCE.
Tennessee Dept. of Health and Environment, Nashville.
P. E. Davis, A. E. Major, and J. N. Dunlap.
Water Environment and Technology, Vol. 1, No. 3, p 426-429, November 1989.

Descriptors: *Tennessee, *Water Quality Act, *Financing, *Wastewater facilities, State revolving funds, Grants, Governmental interrelations, Environmental Protection Agency.

The Water Quality Act of 1987 authorized the establishment of a state revolving fund (SRF) program to replace federal grants for wastewater projects. Tennessee established a SRF administration in the same year. The state was one of the first to receive (March 30, 1988) approval from the Environmental Protection Agency to implement the SRF program. Tennessee's objectives in implementing the SRF program are to create a self-sustaining funding program and maintain a high quality of life by taking a balanced approach to environmental protection and economic development. Tennessee's SRF program provides loans to eligible recipients at or below market rate. The interest rate is based on an index of the recipient's ability to pay. Among the types of projects receiving loans under the SRF are wastewater treatment facilities, nonpoint source projects, groundwater projects, and facility planning/replanning and design. A number of issues were raised during the development and negotiation phases of the Tennessee SRF program. These include: the need to get away from the 'grants mentality' to understanding the nature of a revolving fund concept; the difference between financial institutions' policies on refinancing and the EPA requirements; National Environmental Policy Act review procedures; agreement by Tennessee to ensure recipients compliance with cross-cutting federal laws and authorities; letter of credit problems; and problems with leveraging and guaranteeing debt service. A Wastewater Financing Board also was established in the SRF legislation with the mission of helping cities audit and then correct operating deficits so as to make themselves eligible for SRF loans. (Rochester-PTT)
W90-03958

PRODUCTION, COST, AND INCREASED SALINITY IN WATER.
Central Michigan Univ., Mount Pleasant. Dept. of Economics.
D. E. Agthe, and J. C. Tinney.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 824-828, November 1989. 2 fig, 7 ref.

Descriptors: *Industrial water, *Saline water, *Economic aspects, *Pricing, Cost sharing, Hidden costs, Process water, Damages.

Water customers suffer hidden private costs if complete price information is not provided when the salinity of water increases. Previous attempts to estimate the damages or hidden costs resulting from increased salinity have ignored the impact on the production of goods made with the more saline water. Assuming rational economic behavior and a fixed production budget, an economic rationale is given for including these effects in future damage estimates. Since water most often is used as an input combined with other inputs, derived demand analysis should be used in future damage-estimate studies to account properly for shifts in water use and productivity caused by the unannounced increase in salinity. It is clear that damages are underestimated when lost output from productivity shifts is ignored. An informational campaign by the water utility, if clean-up subsidies are ignored, may be the best way to eliminate the hidden costs to water users. (Author's abstract)
W90-03981

VALUING IRRIGATION WATER IN PUNJAB PROVINCE, PAKISTAN: A LINEAR PROGRAMMING APPROACH.
Agency for International Development, Islamabad (Pakistan).
M. A. Chaudhry, and R. A. Young.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1055-1061, October 1989. 2 tab, 22 ref. US Agency for International Development Project 931-023609.

Descriptors: *Model studies, *Pakistan, *Irrigation, *Water costs, *Agriculture, *Economic aspects, Irrigation efficiency, Water resources management, Model studies.

Linear programming models of a representative farm in a district of Pakistan's Punjab Province are formulated for the purpose of estimating the value of irrigation water. The models provide for choices among several irrigation levels for each potential crop. Solutions of the model for several water supply situations provide the basis for approximating the total, average, and marginal values of irrigation water. Prices for important crops in Pakistan are controlled at levels below their levels elsewhere in the world, so models are specified for both financial (domestic price) and economic (world price) scenarios. The value of water to society (its economic value) is high relative to the costs of some generally available water-augmenting investments while financial values, which measure water management and allocation incentives faced by farmers, are less than the corresponding economic values. At current water supply levels, incremental returns to added water estimated from the economic model would justify investments in water-saving or water-augmenting technologies, while such a decision would be barely attractive assuming current prices. Present government commodity price policies may serve to protect low-income and non-farm members of the population; however, they also inhibit farmer investments to increase the productivity of scarce irrigation water. (Author's abstract)
W90-04211

SAPHO20: AN AID IN WATER PLANNING(SAPHO20: SYSTEME D'AIDE A LA PLANIFICATION DE L'EAU).
Grenoble-2 Univ. (France). Centre de Recherche en Informatique Appliquee aux Science Sociales.
For primary bibliographic entry see Field 6A.
W90-04289

COSTS AND FINANCING OF WATER QUALITY CONTROL.
Georgia Univ., Athens. Inst. of Natural Resources.
R. M. North.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 187-199, 2 tab.

Descriptors: *Water resources development, *Urban hydrology, *Water pollution control, *Financing, *Cost sharing, *Water policy, *Water quality management, Loans, Grants, Water quality control, Economic aspects.

The current situation in financing water projects is discussed, with note made that grant and loan programs comprise more than half of the total outlay. Cost sharing provisions of the President's water policy were reviewed, with several positive aspects noted, including: full recognition of vendible outputs, and revenue sharing on the basis of Federal-non-Federal contributions. Specific problems which must be addressed relative to a workable national policy for financing and cost-sharing of water projects were identified as: proper sources of investment, control of the rate of investment, cost-sharing levels, basis for marketing vendables, determination of national interest in non-vendables, and problems of managing revenue sharing. (See also W90-04338)(Lantz-PTT)
W90-04359

6D. Water Demand

WATER-USE DATA COLLECTION PROGRAM IN MISSISSIPPI.
Geological Survey, Jackson, MS. Mississippi District.
J. A. Callahan, and N. L. Barber.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 53-57. 5 fig, 4 ref.

Descriptors: *Mississippi, *Water use, *Water demand, *Water requirements, *Data acquisition, *Data collections, Municipal water, Industrial water, Agricultural water, Data storage and retrieval, Groundwater basins, Decision making.

During 1973, in recognition of the need for accurate, consistent, site-specific information on water use, the U.S. Geological Survey began the Mississippi Water-Use Program in cooperation with the Miss. State board of Water Commissioners (now the Miss. Bureau of Land and Water Resources). The functions of the program, including its data system, and the findings of the program in terms of public, industrial and thermoelectric power uses of water, are reviewed. Total withdrawals by county are also estimated annually for agricultural water use. Every five years, aggregated water-use statistics are compiled in an Aggregated Water-Use Data System, which is used to provide information for a national report on estimated water use in the United States. Site-specific water-use information is of value to the scientist developing groundwater models, basin budgets, or other detailed projects. Aggregated data are most useful for water management decisions, water-use trend analysis, and for large-scale hydrologic studies. (See also W90-03708) (Friedmann-PTT)
W90-03718

IMPACT ON WATER SUPPLIES.
For primary bibliographic entry see Field 2B.
W90-03924

HYDROPOWER OPTIMIZATION VIA SEQUENTIAL QUADRATIC PROGRAMMING.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3E.
W90-03975

WATER AND URBAN LAND-USE PLANNING IN CALI, COLOMBIA.
Hawaii Univ. at Manoa, Honolulu. Dept. of Geography.
M. A. Ridgley.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 115, No. 6, p 753-774, November 1989. 8 fig, 5 tab, 26 ref.

Descriptors: *Colombia, *Water resources development, *Urban areas, *Management planning, *Water demand, *Developing countries, Biochemical oxygen demand, Cali, Optimization, Algorithms, Mathematical models, Flood control, Nonpoint pollution sources, Regional development.

A multiobjective urban land-use/water-resources model, appropriate for use in less-developed countries (LDCs), is described and applied to Cali, Columbia. Objectives are to minimize service costs and biochemical oxygen demand (BOD) loadings and maximize service levels while accommodating population growth. Vector optimization based on generating techniques allocates new residents to potential urban-expansion zones while simultaneously determining the optimal mix of various water-supply and sanitation systems. Potential flood impacts are then simulated and the results used to constrain development in critical areas. Further flood control and reduction of nonpoint-source pollution via detention basins are examined. Postoptimality analysis shows solutions to be quite sensitive to estimated water consumption and preset density limits. A more sophisticated simulation model could represent the runoff and routing processes more accurately but any attempt to improve upon the simulation in such a way must deal with the very severe data limitations facing stormwater modeling in the developing world. In this study the following data were either unavailable, imprecise, or laborious to collect and verify: plans of the sewage and drainage works; land use and land cover; soils and runoff coefficients; historical rainfall-runoff records; nonpoint-source pollutant loadings; and relations between population density and imperviousness. The linkage between the optimization and the simulation components is probably the weakest point in the procedure. As the number of surcharge points requiring abatement increases, so does the number of development-relocation constraints that must be appended to the multiobjective model. Not only can this become onerous, but with more than one new constraint it makes more complex the elucidation of trade-offs between land-use control and structural methods of runoff management. (Rochester-PTT)
W90-03977

MASSIVE WATER SCARCITY NOW THREATENING AFRICA--WHY ISN'T IT BEING ADDRESSED.
Swedish Natural Science Research Council, Stockholm.
M. Falkenmark.
AMBIO AMBOCX, Vol. 18, No. 2, p 112-118, 1989. 7 fig, 1 tab, 17 ref.

Descriptors: *Water scarcity, *Africa, *Semiarid lands, *Water supply development, *Projections, Water demand, Water shortage, Hydrologic cycle, Future planning, Drought.

Ways have to be found to improve life quality and food security in Africa's semiarid countries, despite the environmental constraints of hydroclimatically-induced water scarcity and the considerable interannular fluctuations that characterize the natural freshwater supply. A water-stress profile is presented on both the role of improved water supply for self-sufficient crop production and the number of individuals jointly depending on each flow unit of waster available to the country from the water cycle. In a medium-term-perspective, water will not be readily available to support improved life quality for growing African populations. There is an urgent need for increased awareness among African leaders so that adequate strategies can be made for development under conditions of severe water scarcity. Such strategies are urgently needed to stop the present multi-risk spiral from producing repeated collapses during recurrent drought years. (Author's abstract)
W90-04004

CONFLICT ANALYSIS AND MANAGEMENT ALTERNATIVE FOR THE MANAYUNK CANAL.
Villanova Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W90-04209

IRRIGATION DEVELOPMENT AND MANAGEMENT ALTERNATIVES OF A DOLOMITE AQUIFER IN NORTHEASTERN ILLINOIS.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 3F.
W90-04213

FROM CROPLAND TO CONCRETE: THE URBANIZATION OF FARMLAND IN VIRGINIA.
Virginia Water Resources Research Center, Blacksburg.
For primary bibliographic entry see Field 4C.
W90-04264

WATER CONSERVATION SCENARIO FOR THE RESIDENTIAL AND INDUSTRIAL SECTORS IN CALIFORNIA: POTENTIAL SAVINGS OF WATER AND RELATED ENERGY.
Lawrence Berkeley Lab., CA. Energy and Environmental Div.
For primary bibliographic entry see Field 3E.
W90-04265

ENERGY FROM THE WEST: SUMMARY REPORT.
Oklahoma Univ., Norman. Science and Public Policy Program.
Report No. EPA 600/9-79-027, August 1979. 38p. EPA Contract 68-01-1916.

Descriptors: *North America, *Policy making, *Water resources development, *Energy sources, *Water use, *Hydroelectric power, Colorado River, Missouri River, Irrigation, Indian rights, Political aspects, Water supply, Water conservation, Environmental impact.

This report summarizes the results of a 3-year Technology Assessment of Western Energy Resource Development, a study which examined the development of coal, geothermal, natural gas, oil, oil shale, and uranium resources in an eight-state area in the western United States (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, and Wyoming). Energy development in the western states, particularly electric power generation using wet-cooling technologies, will add to current water availability problems and intensify existing political conflicts regarding water resource management. The most important water availability issues appear to be the following: water shortages in the Colorado River basin; increased conflicts in the Upper Missouri River basin; damage to environmental resources; conflicts with Indian values; and restriction or elimination of irrigated agriculture. If policy makers try to meet the expanded needs of water users, two general categories of policy alternatives can be considered: (1) increase water supply (augmentation); or (2) increase the use of existing supplies (conservation). Several specific alternatives exist in each of these general categories. Policy makers could take a very different approach by explicitly reducing or eliminating water intensive uses in some areas, including energy development and irrigated agriculture. One of the most critical issues raised by these choices is where the political authority will rest. (See also W78-00753 and W90-04256) (Lantz-PTT)
W90-04269

WATER USE FOR ELECTRIC POWER GENERATION.
Woodward-Clyde Consultants, San Francisco, CA.
For primary bibliographic entry see Field 3E.
W90-04337

OPTIMAL CAPACITY EXPANSION OF A WATER RESOURCE SYSTEM AND ISSUES OF WATER ALLOCATION AND USE: UMATILLA RIVER BASIN, OREGON.
Oregon State Univ., Corvallis. Water Resources Research Inst.
B.-H. Lin, R. G. Kraynick, and H. H. Stoevener.
Water Resources Research Institute, Oregon State University, Corvallis, OR. Feb. 1983. Final Technical Completion Report for Project No. A-046-ORE. 167p. 6 fig, 5 tab, 56 ref, 2 append.

Descriptors: *Water resources development, *Water allocation, *Optimum development plans, *Oregon, Water requirements, Economic aspects, Water rights, Model studies.

Most recent research regarding the design of optimal capacity-expansion plans for water resource systems has emphasized minimization of total cost, given an increasing schedule of water requirements. This focus limits the full applicability of optimal capacity expansion techniques by inadequately treating the criteria of economic efficiency. This study explores scheduling water resource project facilities based on anticipated economic benefits provided. The Umatilla River Basin in northeast Oregon was analyzed with optimal capacity expansion techniques. The objective was to increase the net benefits from irrigated agriculture and fisheries enhancement. A basic scheduling model for irrigation and instream flow maintenance was implemented for the study area and for alternate projects. The ramifications of exchange-theoretic and distribution-theoretic criteria on

timing of facilities and ultimate allocation of water among purposes were then examined. The model, designed along interger programming lines, maximized the present value of net benefits. By optimally timing the facilities, the total present value of net benefits of the project could be significantly enhanced when compared to the original schedule proposed in the project planning documents. Of great interest was the issue of incorporating into the planning process (and specifically into the capacity expansion mode of planning) considerations of appropriative doctrine water rights exchangeable in legal transfers between project beneficiaries or contestable in court. These interrelationships were explored paying particular attention to the way in which exchanges of water (via water rights transfers) could establish higher levels of benefits in future years. Noneconomic processes such as enforcement of extant property rights relating to water resources are another issue which complicates water planning. Ways were explored by which the basic model may be modified and used to take into account those problems. (Author's abstract)
W90-04490

TECHNICAL DESCRIPTIONS OF HUDSON RIVER ELECTRICITY GENERATING STATIONS.
Orange and Rockland Utilities, Inc., Pearl River, NY.
J. B. Hutchison.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 113-120. 7 fig, 6 ref, 4 append.

Descriptors: *Thermal powerplants, *Environmental effects, *Hudson River Estuary, *Water use, *Water resources development, *Nuclear powerplants, Fossil fuel plants.

Six fossil-fueled and one nuclear electricity generating plants are sited along the Hudson River estuary between kilometers 8 and 228, measured from the river mouth. Their aggregate rated capacity is 5,798 MW of electricity; operating at that capacity they would withdraw cooling water from the river at the rate of 1.5 x 10 to the 9th power cu m/d and reject heat at the rate of 155 x 10 to the 9th power kcal/d. Three of these plants, the fossil-fueled Roseton and Bowline and the nuclear Indian Point facilities, account for 75% of total rated capacity, 62% of maximum water withdrawal, and 79% of potential heat rejection. These three plants and a proposed (but never built) pumped-storage facility at Cornwall, all sited between km 60 and 106, were the focus of environmental litigation. The Indian Point plant normally operates at 100% generation capacity; the other plants may experience daily operating load changes that vary from approximately 50% to 100% of total generation capacity, depending on system electrical demand or economic considerations. All plants experience periodic unscheduled outages for repairs. (See also W90-04505) (Author's abstract)
W90-04511

6E. Water Law and Institutions

SCIENTIFIC, TECHNICAL AND REGULATORY CONSIDERATIONS IN ENVIRONMENTAL MANAGEMENT.
Alaska State Dept. of Environmental Conservation, Juneau. Water Quality Management Section.
For primary bibliographic entry see Field 5G.
W90-03625

SUMMARY OF THE 1986 AMENDMENTS TO THE SAFE DRINKING WATER ACT.
Environmental Protection Agency, Atlanta, GA. Region IV.
W. B. Crum.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 27-32. 6 tab, 5 ref.

Descriptors: *Safe Drinking Water Act, *Water law, *Water policy, *Administrative regulations, *Drinking water, *Water quality control, *Water quality standards, Coliforms, Heavy metals, Trace elements, Organic compounds, Radioisotopes.

The Safe Drinking Water Act (SDWA) of 1974 includes legislation that gives the Environmental Protection Agency (EPA) ultimate authority over all public water supplies. The 1986 amendments ot the SDWA require that EPA develop numerical standards or a treatment technique for 83 drinking water contaminants based upon the degree to which the contaminants can be removed using best available treatment technologies. The 83 contaminants that are regulated according to the amendments, including volatile organic chemicals, microbes, inorganic compounds and heavy metals, organic compounds and radionuclides, are listed. Also, proposed maximum contaminant level goals per proposed rules for other synthetic organic chemicals, volatile organic chemicals, radionuclides, total coliforms, and inorganic chemicals, as stipulated in the amendments, are listed. (See also W90-03708) (Friedmann-PTT)
W90-03713

SAFE DRINKING WATER ACT: AMENDMENTS, REGULATIONS AND STANDARDS.
For primary bibliographic entry see Field 5G.
W90-03730

HISTORICAL DEVELOPMENT OF THE NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
For primary bibliographic entry see Field 5G.
W90-03731

OVERVIEW OF THE CURRENT NATIONAL PRIMARY DRINKING WATER REGULATIONS AND REGULATION DEVELOPMENT PROCESS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5F.
W90-03732

COMPLIANCE BY PUBLIC WATER SUPPLY SYSTEMS WITH NATIONAL PRIMARY DRINKING WATER REGULATIONS.
Environmental Protection Agency, Boston, MA. Water Supply Branch.
For primary bibliographic entry see Field 5G.
W90-03739

DRINKING WATER QUALITY AND WATER TREATMENT PRACTICES: CHARTING THE FUTURE.
Massachusetts Univ., Amherst. Div. of Public Health.
For primary bibliographic entry see Field 5F.
W90-03740

WATER RIGHTS DOCTRINES AS LIMITATIONS ON WATER RESOURCES DEVELOPMENT.
Virginia Polytechnic Inst., Blacksburg. Water Resources Research Center.
W. R. Walker, and W. E. Cox.
Virginia Water Resources Research Center Final Technical Completion Report, November 16, 1977. 8 p. Agreement 14-31-001-3361, OWRT Project No. B-040-VA(1).

Descriptors: *Water rights, *Water resources development, Water use, Water transfer, Water law, State jurisdiction, Federal jurisdiction.

A project was conducted to identify areas where water rights doctrines hold the potential to frustrate efficient water resources development and utilization. More specific objectives include: (1) to determine the extent to which waste and inefficient uses are prohibited; (2) to evaluate constraints on transfer of water to more efficient uses; (3) to identify biases against certain types of use, e.g., instream uses; (4) to assess the significance of impediments to transfer water from areas of surplus to areas of deficit; (5) to identify water rights uncertainties that adversely affect maximization of benefit; (6) to evaluate the extent and impact of compartmentalization of the hydrologic cycle within the water doctrines; and (7) to develop recommendations for water law modifications to alleviate existing problems. The majority of the research effort was devoted to analysis of state status and decisions of state supreme courts concerning water use. Research has indicated that all the potential problem areas explored serve to impede effective water utilization to some degree in certain situations. However, the occurrence and severity of specific problems varies considerably among the individual states. (Lantz-PTT)
W90-03741

WATER RESOURCE MANAGEMENT: INTEGRATED POLICIES.
Organization for Economic Co-Operation and Development, Paris (France).
For primary bibliographic entry see Field 6A.
W90-03746

REGULATORY IMPACT ANALYSIS OF THE PROPOSED REGULATIONS FOR SEWAGE SLUDGE USE AND DISPOSAL.
Environmental Protection Agency, Washington, DC. Economic Analysis Div.
A. Jones, L. Knight, and D. Meyers.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-136634. Price codes: A18 in paper copy, A01 in microfiche. January 18, 1989. 451p, 2 append.

Descriptors: *Sludge disposal, *Sludge utilization, *Regulations, *Economic effects, *Waste disposal, Municipal wastewater, Landfills, Incineration, Ocean dumping, Land disposal, Wastewater treatment, Case studies, Public health.

The economic impacts of proposed regulations pertaining to the use and disposal of sewage sludge generated by publicly owned treatment works are evaluated. The analysis also evaluates the impacts associated with three other regulatory options, each reflecting a different set of regulatory requirements and varying levels of stringency. Six conventional sludge use and disposal practices are addressed: (1) landfilling, (2) incineration, (3) ocean disposal, (4) surface disposal, (5) distribution and marketing, and (6) land application. A profile is provided of the wastewater treatment industry, with an analysis of the costs associated with complying with the proposed regulation and the three other regulatory options, as well as a case study analysis to assess the impacts of pretreatment as it pertains to the proposed regulation baseline health risks of sludge use and disposal are summarized and the benefits (expressed as the reduction in health risks) associated with the proposed regulation are estimated. (Author's abstract)
W90-03761

PUBLIC POLICY ON GROUND WATER QUALITY PROTECTION.
For primary bibliographic entry see Field 5G.
W90-03771

UNDERGROUND INJECTION PROGRAM UNDER THE NATIONAL SAFE DRINKING WATER ACT.
New Mexico State Univ., Las Cruces.
For primary bibliographic entry see Field 5G.
W90-03782

IMPACT OF FEDERAL LEGISLATION OTHER THAN THE SAFE DRINKING WATER ACT ON GROUND-WATER PROTECTION.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5G.
W90-03783

STATE APPROACH TO GROUND-WATER PROTECTION: THE PENNSYLVANIA EXPERIENCE.
Pennsylvania Dept. of Environmental Resources, Harrisburg. Ground Water Section.
For primary bibliographic entry see Field 5G.
W90-03784

STATE APPROACH TO GROUND-WATER QUALITY PROTECTION: THE ILLINOIS EXPERIENCE.
Illinois State Environmental Protection Agency, Springfield. Div. of Land Pollution Control.
For primary bibliographic entry see Field 5G.
W90-03785

ROLE OF INTERSTATE COMMISSIONS IN GROUND-WATER PROTECTION: THE SUSQUEHANNA RIVER BASIN COMMISSION PERSPECTIVE.
Susquehanna River Basin Commission, Mechanicsburg, PA.
J. Hollowell.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 124-129, 1 ref.

Descriptors: *Interstate commissions, *Groundwater quality, *Regulations, *Susquehanna River Basin, *Water pollution prevention, *Pennsylvania, Water quality control, Standards, Legislation, Monitoring.

The Susquehanna River Basin Commission has the legislative authority to assume jurisdiction to 'preserve, protect, improve, and develop the quality of the waters of the basin in accordance with the Comprehensive Plan,' with 'waters' defined as including both surface and underground waters. However, the Commission has assumed a policy 'to encourage and coordinate the efforts of the signatory parties to prevent, reduce, control, and eliminate water pollution and to maintain water quality as required by the Comprehensive Plan.' In this role, the Commission at present has chosen to review and evaluate the signatory parties' regulatory programs governing underground waste discharges, rather than assume a more active regulatory role. Commission concern and action was reflected in the recent adoption of a resolution seeking cooperative action and support by the signatory agencies to: (1) impose more stringent requirements in the submission of information on waste characteristics, subsurface environment, and design of disposal systems as part of the permit applications; (2) require all compliance monitoring samples be conducted by a state-certified laboratory; (3) conduct on-site evaluations of proposed disposal areas in cases where toxic or nonbiodegradable substances are a potential in the effluent and require appropriate pretreatment and stringent monitoring; and (4) assure proper staff evaluation of permit application by charging a permit application and compliance monitoring fee. (See also W90-03771) (Lantz-PTT)
W90-03786

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER COMMISSION VIEW.
Camp, Dresser and McKee, Inc., Belmont, CA. Water Resources Div.
H. O. Banks.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 144-154, 12 ref.

Descriptors: *Groundwater quality, *Water pollution prevention, *Water resources institutes, *Institutional constraints, Water resources development, Water resources management, Water management, Groundwater management, Surface water, Land use, Federal jurisdiction, State jurisdiction, Administrative agencies, Policy making, Water law, Quality control, National Water Commission.

The National Water Commission considered a wide variety of subjects relating to the water resources of the nation, and to water-resource utilization and development. Of particular interest are reports on state water laws; on groundwater law, management, and administration; and on groundwater management. The Commission completed its work and submitted it final reports, incorporating conclusions and recommendations, to the President and the Congress in 1973. The commission recommended: (1) Comprehensive conjunctive management of surface and groundwater resources under state law; (2) extension of the regulatory and enforcement authority of the Environmental Protection Agency to groundwater, but with a more rational basis for setting water-quality standards; (3) increased emphasis on protection of groundwater quality; (4) vesting of primary responsibility for groundwater quality control in the states; (5) enactment of comprehensive state statutes for control, protection, and management of surface and ground waters; (6) creation of public water resource-management agencies with broad powers; (7) greater attention by congress and federal agencies to groundwater problems, protection, and management; and (8) regulation of land use by the states or local political subdivisions as necessary to control or eliminate adverse effects on groundwater quality resulting from land uses. The recommendations of the National Water Commission offer a sound basis for management of the nation's groundwater resources, including protection of groundwater quality. However, it appears that little has been done to implement those recommendations since the Commission's reports in 1973. (See also W90-03771) (Lantz-PTT)
W90-03788

INSTITUTIONAL REQUIREMENTS FOR GROUND-WATER PROTECTION: THE NATIONAL WATER WELL ASSOCIATION VIEW.
National Water Well Association, Worthington, OH.
J. H. Lehr.
IN: Public Policy on Ground Water Quality Protection. Proceedings of a National Conference, April 13-16, 1977, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Virginia Water Resources Research Center, Blacksburg, Virginia. (1977). p 155-158.

Descriptors: *Groundwater quality, *Water pollution prevention, *Water resources institutes, *Institutional constraints, Water law, Regulations, Federal jurisdiction, State jurisdiction, Interagency cooperation, National Water Well Association.

It takes nothing less than a bureaucrat to cope with the myriad requirements mandated in public laws, whether they be the Water Pollution Control Act, the Safe Drinking Water Act, the Toxic Substances Control Act, or the Resource Conservation and Recovery Act. The result is an increase of bureaucrats in Washington and a concurrent expansion of the scientific community throughout state governments. What is needed in Washington today is logistical support for the state professional water scientist and regulator so that they can make the solution fit the problem at the most pragmatic level. We may be approaching the point where the least rigid regulation is the best regulation. As state after state becomes concerned about its potential groundwater pollution problems, good things are happening without the prod of federal legislation. It is hoped, therefore, that the besieged personnel throughout the Environmental Protection Agency's water and waste program offices can find it possible within the law to govern best by governing least. (See also W90-03771) (Lantz-PTT)
W90-03789

UTILITY OF ENVIRONMENTAL FATE MODELS TO REGULATORY PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 5B.
W90-03838

GROUNDWATER POLLUTION LITIGATION IN THE FEDERAL COURTS: AN EVALUATION OF THREE NEW PRIVATE REMEDIES.
Office of the Associate Attorney General, Washington, DC. Land and Natural Resources Div.
For primary bibliographic entry see Field 5G.
W90-03898

CSO PARTNERSHIP: CITIES JOIN FORCES ON COMBINED SEWERS.
Greeley and Hansen, Camp Springs, MD.
For primary bibliographic entry see Field 5E.
W90-03954

WATER QUALITY 2000: BUILDING A NATIONAL CONSENSUS.
For primary bibliographic entry see Field 5G.
W90-03957

PCB-POLLUTION PROBLEM IN THE UPPER HUDSON RIVER: FROM ENVIRONMENTAL DISASTER TO 'ENVIRONMENTAL GRIDLOCK'.
Barnard Coll., New York. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-04026

ENVIRONMENTAL QUALITY OBJECTIVES AND EFFLUENT CONTROL.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5G.
W90-04092

DETERMINATION OF AN OPTIMAL POLICY FOR PROTECTING GROUND WATER QUALITY.
Economic Research Service, Washington, DC. Resources and Technology Div.
For primary bibliographic entry see Field 5G.
W90-04174

NEW JERSEY'S PROGRAM.
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 5G.
W90-04227

LOCAL OPTIONS FOR GROUNDWATER PROTECTION.
For primary bibliographic entry see Field 5G.
W90-04228

CLASSIFYING AQUIFERS.
For primary bibliographic entry see Field 2F.
W90-04229

FEDERAL INVOLVEMENT IN GROUNDWATER PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 5G.
W90-04231

LEGAL AUTHORITY TO PROTECT GROUNDWATER IN VIRGINIA.
M. T. Jacks.
IN: Virginia's Groundwater. Proceedings of a Symposium Organized by the Environmental Defense Fund, November 9-10, 1983. Virginia Polytechnic Institute and State University, Blacksburg. 1984. p 86-89.

Descriptors: *Groundwater management, *Virginia, *Legislation, *Regulations, *Groundwater quality, *Water quality control, Water pollution prevention, State jurisdiction, Institutions.

The General Assembly of Virginia has enacted the State Water Control Law, whereby state waters are defined to include all waters, both on the surface and under the ground. As a result, the term 'state waters' includes groundwater. Section 2 of the law asserts that it is the Commonwealth's policy to protect existing high quality state waters and restore other state waters to a condition that

will permit all reasonable public uses and will support the propagation and growth of all aquatic life and game fish that might reasonably be expected to inhabit those waters. Section 5 of the Law declares that it is against public policy to discharge harmful substances or inadequately treated wastes into state waters or to otherwise alter the properties of state waters to make them detrimental to public health, to animal or aquatic life, for domestic or industrial consumption, or for recreation or other uses. Section 34 relates to discharge of oil into state waters (including groundwater). This provision makes any person, firm, or corporation liable, without fault, for causing or permitting a discharge of oil into state waters or owning any facility, vessel, or vehicle from which there is a discharge of oil into state waters. Section 15 of the Water Control Law establishes the duty and the authority of the State Water Control Board (SWCB) to supervise and control the quality, management, and distribution of all state waters and to enforce and administer the Water Control Law. Virginia's principal means of protecting the quantity of groundwater is the Groundwater Act of 1973. The act provides that the SWCB can declare an area a groundwater management area if it finds that groundwater levels there have been, or are, declining, or that wells in that area interfere with one another, or that the available groundwater supply is, or is about to be, overdrawn or polluted. The final areas of the law applicable to the protection of groundwater quality in Virginia are hazardous waste and solid waste laws enforced by the State Board of Health. (See also W90-04221) (Lantz-PTT)
W90-04232

PROGRAMS TO PROTECT GROUNDWATER IN VIRGINIA.
Virginia State Water Control Board, Richmond.
For primary bibliographic entry see Field 5G.
W90-04233

LAND APPLICATION AND DISTRIBUTION AND MARKETING OF SEWAGE SLUDGE.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5E.
W90-04273

LET'S LOOK AT SOME LEGAL IMPLICATIONS OF STREAMFLOW FORECASTING.
Stetson Engineers, Inc., San Francisco, CA.
T. M. Stetson.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 312-321, 12 ref.

Descriptors: *Streamflow forecasting, *Water allocation, *Water law, *Legal aspects, *Colorado River, Colorado River Compact, Water rights, California, Arizona, Nevada, Water supply.

Congressman Frank Mondell of Wyoming was responsible for the legislation which became law on August 19, 1921 which authorized the seven states of the Colorado River Basin to enter into an agreement to apportion the waters of the Colorado River. This resulted in the Colorado River Compact, which was signed at Santa Fe, New Mexico, in 1922. Briefly stated, it divided the water supply of the Colorado River between the Upper Colorado River Basin and the Lower Colorado River Basin at what is known as the Compact Point, Lee Ferry, Arizona. Immediately after the Colorado River Compact was signed, strenuous efforts were made to get a large dam and reservoir constructed on the Colorado River at or near Boulder Canyon to provide flood protection and to firm up water supplies for Lower Basin water users. The Swing-Johnson bill, which finally resulted in the Boulder Canyon Project Act and the construction of the Project, including Hoover Dam and Lake Mead, was signed on December 21, 1928. The quantity of the water supply of the Colorado River was the most important factual question in the Arizona vs. California litigation of the 1950's. The legal implications from this litigation and subsequent projects can be succinctly stated: law suits. Unfortunately, law suits may end up redistributing water supplies but they seldom develop new water. There have been five legal actions brought in the U.S. Supreme Court in attempting to resolve the conflicts in the Lower Colorado River Basin; all but one action were dismissed or denied. In the final suit, Arizona brought suit in 1952 against the State of California and seven public agencies in California. The case was decided by the Supreme Court in 1963. But even then, certain matters were left open for further resolution by the parties. Future litigation concerning the Colorado River is expected to focus on water quality, environmental matters or other water related problems, such as property boundary changes due to changing course of the river. (See also W90-04398) (Lantz-PTT)
W90-04329

LOCALLY IMPORTANT ECONOMIC CONSIDERATIONS IN FLOODING AND FLOOD PLAIN MANAGEMENT.
For primary bibliographic entry see Field 6F.
W90-04333

ALTERNATIVES FOR STANDARDS AND REGULATIONS.
Federal Insurance Administration, Washington, DC.
For primary bibliographic entry see Field 6F.
W90-04334

WATER PROBLEMS OF URBANIZING AREAS.
For primary bibliographic entry see Field 4C.
W90-04338

SECTION 208 PLANNING PROCESS--THE FEDERAL VIEW.
Environmental Protection Agency, Washington, DC. Water Planning Div.
W. S. Groszyk.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 13-17.

Descriptors: *Regional planning, *Water Pollution Control Act, *Urban hydrology, *Water pollution control, *Water quality control, *Water quality management, *Legislation, Economic aspects, Federal jurisdiction, Storm runoff, Urban runoff.

The Environmental Protection Agency's (EPAs) Section 208 of the Water Pollution Control Act planning is underway everywhere for the entire surface area of the United States except American Samoa. 176 area-wide agencies representing local government have been designated to do 208 planning as well as 49 states and territories. In several states, the planning is being performed entirely by area-wide agencies. To date, $225 million in Federal funds has been obligated for this program, and another $75 million is available in EPA Regional Offices for obligation. Of the 225 planning efforts that have been initiated, 114 are in or through the process of local government adoptions; 21 of these plans have been certified by the State; and two have been approved by EPA. From an EPA standpoint, the desire was to secure a long-term funding commitment from the Office of Management and Budget (OMB) for the program, and to increase the FY 1978 budget request. A total Federal cost of the program was projected as being $542 million for the period between fiscal years 1978 and 1983. These funds would cover activities under four major categories: facilities planning for municipal treatment works, urban stormwater runoff, pretreatment, and nonpoint sources. The greatest portion of funds would be used for nonpoint sources, followed by urban stormwater runoff. Significant changes have been made in revised regulations including procedures covering changes in designation of agencies. Regulations also cover the major transition that will occur in the 208 program over the next several years. EPA is also imposing a funding sanction beginning in fiscal year 1980--no planning agency, state or areawide, can receive any additional planning funds unless a portion of a previously approved 208 plan is being implemented. The regulations also require timely action by the states on the certification of plans, especially areawide plans. (See also W90-04338)(Lantz-PTT)
W90-04339

STATE ASPECTS OF 208 PLANNING.
Virginia State Water Control Board, Richmond. Bureau of Water Control Management.
D. F. Jones.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 17-23.

Descriptors: *Urban hydrology, *Water pollution control, *State jurisdiction, *Regulations, *Water quality management, *Management planning, *Virginia, *Water Pollution Control Act, *Nonpoint pollution sources.

No one has yet seriously challenged the overall goal of the Clean Water Act to provide fishable and swimmable water by 1983 throughout the United States. There is growing concern, however, about how to meet this goal, and whether there will ever be enough money to do so. Virginia started early with the planning required by Section 208 of the Federal Water Pollution Control Act of 1972. The seven designated 208 areas and corresponding designated agencies were approved by EPA to develop water quality management plans. The agencies were to be supported through 100% Federal funding during an initial two-year planning period, after which the State Water Control Board (SWCB) became responsible for oversight certification of the designated areas. The keystone of Virginia's nonpoint source control strategy is the recommendation of best management practices (BMPs) for the various categories of nonpoint sources. EPA defines the term best management practices as a practice that is determined by a state to be the most effective, practicable (including technological, economic and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals. EPA has identified eight categories of nonpoint sources: (1) agriculture, (2) silviculture; (3) mining; (4) construction; (5) urban; (6) hydrologic modifications; (7) sources affecting groundwater; and (8) residual wastes disposal. The SWCBs main project in its first year of Statewide 208 planning is the development of BMP Handbooks for six of these categories. The existing Virginia Erosion and Sediment Control Handbook is being used as the BMP Handbook for construction activities. The statutory authority for implementation of 208 plans is provided for in the Virginia State Water Control Law (SWCL). The aim of the 208 plan is to identify present and future sources of pollution and to provide methods to control those sources so that clean water, once achieved, will be maintained. (See also W90-04338)(Lantz-PTT)
W90-04340

EXPERIENCES AND PERCEPTIONS OF THE 208 PROGRAM AT THE SUBSTATE LEVEL.
Middlesex County Planning Board, New Brunswick, NJ.
For primary bibliographic entry see Field 6A.
W90-04341

NATIONAL WATER POLICY.
Library of Congress, Washington, DC. Congressional Research Service.
For primary bibliographic entry see Field 6A.
W90-04342

INSTITUTIONAL PROBLEMS IN IMPLEMENTING WATER QUALITY CONTROL.
Colorado State Univ., Fort Collins. Dept. of Political Science.
H. P. Caulfield.
IN: Water Problems of Urbanizing Areas. Pro-

ceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 47-52.

Descriptors: *Governmental interrelations, *Urban hydrology, *Water pollution control, *Institutions, *Water quality control, *Water quality management, Local governments, Federal jurisdiction, State jurisdiction, Wastewater facilities, Water reuse, Water pollution sources, Flood plain management, Land use, Water conservation.

Identification of institutional problems implies that institutional change is to be sought; that is, change in constitutions, laws, legal decisions, regulations, policies and habitual ways of doing thins as well as change in organizational arrangements. The substantive problems that are of interrelated concern and that provoke institutional problems include the following: (1) Wastewater facility and land return-flow management--point and nonpoint sources; (2) Water reuse--planned reuse for industrial and agricultural use and, ultimately, for domestic use; (3) Water conservation--to lessen demand on wastewater treatment facilities and water supply facilities; (4) Flood plain management; and (5) General land use planning and management. In addition to constitutional and political matters, specific problems need to be identified in: local institutions (i.e., planning, water supply, cities vs. counties), the Federal government, and the Federal-State River Basin commissions. (See also W90-04338)(Lantz-PTT)
W90-04343

PROTECTION OF LAKES AND WETLANDS.
Rutgers - The State Univ., New Brunswick, NJ. Water Resources Research Inst.
For primary bibliographic entry see Field 5G.
W90-04356

WATER QUALITY MANAGEMENT ALTERNATIVES.
Miami Univ., Oxford, OH. Inst. of Environmental Sciences.
For primary bibliographic entry see Field 6A.
W90-04357

MOST APPROPRIATE ONGOING WASTEWATER INSTITUTIONS (ORGANIZATION FOR AREAWIDE WATER QUALITY PLANNING).
Colorado State Univ., Fort Collins. Dept. of Political Science.
H. P. Caulfield.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 200-218, 1 fig.

Descriptors: *Wastewater facilities, *Urbanization, *Urban hydrology, *Colorado, *Institutions, *Water pollution control, *Water quality management, State jurisdiction, Water Pollution Control Act, Best management practice, Regulations, Waste management, New Jersey.

Larimer and Weld Counties, Colorado decided to work within the existing institutions and to assign new functions for carrying out the Water Pollution Control Act Section 208 program to existing agencies. The 'planning' and surveillance function were assigned to the Council of Governments (COG). All management functions including taxing power, the receipt of grants, land use controls, responsibilities to supply water, and wastewater management were to remain with the existing legal entities--the counties and the incorporated cities and towns. The two counties involved were non-home rule. This factor, with relatively weak annexation laws in Colorado, suggested the creation of 'urban service areas' around each of the three major cities as a viable approach. In such areas, the planning would be done by the cities and adopted only with approval of the counties. Best management practices (BMPs) were to be utilized for the control of pollution from nonpoint sources, but only after the completion of two watershed demonstration projects. Waste treatment from point sources was to be limited to secondary treatment. The state role was to be limited to the classification of streams within the management area, determining the level of treatment from waste management facilities, the enforcement of regulations, and establishment of priorities for Federal funds. The Colorado approach was then contrasted with the problems of Section 208 planning in urbanizing settings in New Jersey where all areas are incorporated, where boundaries are not along hydrologic lines, and administrative direction came from two EPA offices with different perspectives. The discussion centered on whether objectives within each planning area can be related to state and EPA objectives, the problems of identifying the expectations of different political units and how they can be resolved where conflict exists, whether planning sub-basin by sub-basin is a proper procedure, and the need to have a mechanism to integrate the planning at this level with that being done for a newer basin. (See also W90-04338)(Lantz-PTT)
W90-04360

TOXICS AND THE SAFE DRINKING WATER ACT.
Passaic Valley Water Commission, Clifton, NJ.
W. Inhoffer.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 242-251.

Descriptors: *Organic compounds, *Urban hydrology, *Water pollution control, *Safe Drinking Water Act, *Water quality control, *Drinking water, *Regulations, Norfolk, Virginia, Water quality management, Economic aspects, Water pollution sources, Research priorities, Water treatment, Public health.

Water suppliers have reacted to the Safe Drinking Water Act and regulations in a responsible manner, questioning the need and validity of organic removal standards. In the Norfolk Virginia, water system, implications of the Safe Drinking Water Act's proposed organic regulations will have a significant impact. Norfolk is taking necessary action to determine whether there is a problem, what is the extent of the problem, and what the most feasible and economical means of action may be. The program includes the following: (1) construction of in-house capability to conduct organic studies; (2) a baseline water quality management study for surface water reservoirs; and (3) various treatment modification studies, including ozone treatment capability or relocation of the chlorination application point. The costs of these various problem identification studies is approximately $300,000 for FY 79. Regulations setting limits on organics are premature since much data and research both on the health effects and treatment effectiveness is needed before large expenditures should be made to implement them. Recommendations for research includes: health effects studies of organics to establish risk information and permissible levels in water; studies to investigate granulated activated carbon adsorption/desorption phenomena and development of treatment design guidelines, criteria, and costs; studies to determine potential economic and health damages for water systems with various levels of organics; studies of analytical techniques and methodologies aimed at reducing costs for organic analyses; and, studies of alternative strategies to reduce the morbidity and mortality due to cancer and other diseases related to organics in water supplies. (See also W90-04338) (Lantz-PTT)
W90-04363

REHABILITATION OF WATER SYSTEMS.
Massachusetts Metropolitan District Commission, Boston.
For primary bibliographic entry see Field 5F.
W90-04364

WASTEWATERS: A PERSPECTIVE.
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 5G.
W90-04393

PUBLIC INVOLVEMENT IN FEDERAL WATER RESOURCE AGENCIES: AN ASSESSMENT OF LEGAL OPTIONS AND CONSTRAINTS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Virginia Water Resources Research Center.
P. M. Ashton.
Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA. Project B-064-VA. 54p.

Descriptors: *Administrative agencies, *Federal jurisdiction, *Legal aspects, *Public participation, Institutional constraints, Decision making, Project planning, Water resources management.

The legal options and constraints that circumscribe public participation in the decision making and project planning processes of federal environmental and water resource agencies were investigated. Public participation is frequently espoused as a desirable component of agency decision making processes. In practice, however, such public involvement is severely limited by a number of legal and practical obstacles which must be overcome before a private citizen or a citizen group may interact effectively with agency officials. The extent and implications of some of the major legal barriers to public participation and public challenge of agency actions are reviewed and a number of possible legal remedies for enhancing the opportunity for effective and substantive interaction are discussed. (Author's abstract)
W90-04495

HUDSON RIVER SETTLEMENT AGREEMENT: TECHNICAL RATIONALE AND COST CONSIDERATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 6B.
W90-04524

HUDSON RIVER COOLING TOWER PROCEEDING: INTERFACE BETWEEN SCIENCE AND LAW.
LeBoeuf, Lamb, Leiby and MacRae, New York.
G. S. P. Bergen.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 302-306. 2 ref.

Descriptors: *Hudson River Estuary, *Environmental effects, *Thermal powerplants, *Nuclear powerplants, *Environmental policy, Legal aspects, Regulations, Public policy, Cooling towers, Estuarine fisheries.

As the Hudson River power plant case proceeded, the regulatory ground shifted under the utility companies. At first, the U.S. Environmental Protection Agency (EPA) contended that the utilities should build expensive closed-cycle cooling towers at three plants to minimize the plants' discharge of heated effluents to the river. When the formal hearing began, however, EPA claimed that cooling towers were needed to minimize the number of organisms impinged at and entrained through the plants. These two issues--thermal discharges and cooling water intakes--fall under separate subsections of the 1972 federal Clean Water Act; whether the two subsections should be considered independently of one another, as the EPA asserted, or in combination to address the total power plant impact on adult fish populations, as the utilities believed was a matter of contention. The Hudson River proceeding became a policy dispute over what the appropriate standard of environmental conduct should be, instead of a determination of whether a standard had been met or not. Such policy issues, which arise when legal precedent has yet to be developed for new laws like the Clean Water Act, are better addressed by a rule-making proceeding than by the adjudicatory hearing format used in the Hudson case. A rule-making

proceeding would have markedly shortened the Hudson deliberations, probably without substantive change in the final settlement, and is recommended for future cases in which ambiguity in legislation or the lack of precedent has left policy matters unresolved. (See also W90-04505) (Author's abstract)
W90-04527

WHAT WE LEARNED ABOUT THE HUDSON RIVER: JOURNEY TOWARD AN ELUSIVE DESTINATION.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 6A.
W90-04528

6F. Nonstructural Alternatives

TUSCON, ARIZONA, FLOOD OF OCTOBER 1983.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-03688

HUMAN STABILITY IN A HIGH FLOOD HAZARD ZONE.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04186

NEW LOOK AT FLOOD RISK DETERMINATION.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-04197

PROCEEDINGS OF A SEMINAR ON FLOOD DAMAGE REDUCTION RECONNAISSANCE-PHASE STUDIES.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A201 926. Price codes: A06 in paper copy, A01 in microfiche. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. (1988). 181p.

Descriptors: *Nonstructural alternatives, *Flood damage, *Flood plain management, Conferences, Management planning, Flood control, Evaluation, Decision making, Economic aspects, Feasability studies.

Papers and discussions at this seminar focus on the conduct and subsequent processing of the reconnaissance-phase of flood damage reduction feasibility studies. The feasibility study encompasses all activities up to a decision to proceed with design and implementation. The feasibility investigation is a continuous process involving two phases, the reconnaissance-phase and feasibility-phase. The reconnaissance-phase defines the flood related problems, identifies potential solutions and determines whether planning should proceed to the feasibility-phase, i.e. is there a feasible alternative for reducing flood losses for which there is federal interest. A significant portion of the presentations and discussions involved study approaches and scope and reliability requirements for the technical analyses. The general consensus was that the reconnaissance study documentation or report should contain a description of: (1) the existing flood problem, (2) formulation of alternatives, (3) evaluation of alternatives and identification of a feasible plan from the federal perspective. The panelists and others discussed means of producing the desired technical products given the limitations of time and funds. They expressed the need to better plan the technical investigations and to use various types and levels of applied methods for analyses. Essential elements of the work plans are to: (1) define the objectives of the respective analyses; (2) define the technical analysis study limits; (3) document available technical information; (4) outline analysis strategies; and (5) develop a study schedule and cost estimate. (See W90-04235 thru W90-04246) (Lantz-PTT)
W90-04234

OVERVIEW OF THE RECONNAISSANCE-FEASIBILITY STUDY AND PLANNING PROCESS-PROGRAM.
Corps of Engineers, Washington, DC.
For primary bibliographic entry see Field 6A.
W90-04235

HYDROLOGIC AND HYDRAULIC ANALYSIS FOR LAS VEGAS WASH AND TRIBUTARIES, NEVADA.
Army Engineer District, Los Angeles, CA.
For primary bibliographic entry see Field 2E.
W90-04236

RECONNAISSANCE STUDIES A HYDROLOGIC ENGINEER'S PERSPECTIVE.
Army Engineer District, Omaha, NE.
For primary bibliographic entry see Field 7B.
W90-04237

FLOOD DAMAGE ANALYSIS--GRANDVIEW HEIGHTS CASE STUDY.
Corps of Engineers, Huntington, WV. Huntington District.
J. Twohig, W. Hunter, and V. Reck.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 41-58, 5 tab, 3 plates.

Descriptors: *Nonstructural alternatives, *Flood damage, *Case studies, *Flood plain management, Scioto River, Ohio, Grandview Heights, Costs, Reservoirs, Flood control, Levees, Channel improvement.

Situated in west central Ohio, the City of Grandview Heights is located in Franklin County, Ohio, on the Scioto and Olentangy Rivers. Floods in the area are not limited to any specific time of the year, although winter and spring floods are more frequent than summer floods. Since major flooding has not occurred in the area since 1959, local residents were not aware of the severity of the potential problem until completion of the Flood Insurance Study for the City in 1980. In May 1983 the City of Grandview Heights, Ohio requested the Corps to initiate studies to determine the feasibility of providing additional flood protection to the City. The Reconnaissance Study was initiated in May 1986 and completed in September 1987. Potential solutions were identified and screened for effectiveness. Those solutions which appeared to be effective were combined to form alternative plans of development. Measures which had been identified are: Floodplain Regulation and Flood Insurance; Temporary Floodplain Evacuation; Permanent Floodplain Evacuation and Floodproofing; Channel Modification; Floodwalls and Levees; and Reservoirs. The alternative selected during the reconnaissance study consists of a floodwall/levee project that incorporates a portion of an existing railroad embankment along the Scioto River. (See also W90-04234) (Lantz-PTT)
W90-04238

FLOOD DAMAGE ANALYSIS RECONNAISSANCE PHASE STUDIES.
Army Engineer District, Rock Island, IL. Economic and Social Analysis Branch.
P. D. Soyke.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 59-67, 2 tab.

Descriptors: *Nonstructural alternatives, *Flood damage, *Reconnaissance studies, *Flood plain management, Economic feasibility, Feasibility studies, Illinois, Iowa, Economic aspects.

From an economist's perspective, the efforts for Reconnaissance Studies have not changed. However, the reliability of the analysis may change significantly. This is dependent on the information available and the amount of time allowed to complete the study. Scheduling of work is probably the major problem to be faced. Even though the 12-month time frame may be realistic when considering a single study, it may not be in the overall program. The economist must be sensitive to the uncertainties of the analysis. Prior to the cost sharing, any uncertainties could be taken care of during the feasibility phase. This can still be done, but adds a greater risk to credibility. In the Rock Island District (Iowa and Illinois), the easy projects seem to have been built. The remaining studies have complications or problems associated with them which increases the uncertainties and creates problems in equity between different sponsors. A large urban area may have sufficient information to allow the damage evaluation to proceed early and efficiently. A smaller community may require additional data collection and result in an analysis that has a wide range of assumptions built in. The urban area is more likely to be able to afford the risk than is a small community, but the risk is usually greater in the small community. This raises some equity issues. It may also mean that in some cases, studies may not be done in small areas that have a need but cannot afford the risk involved in financing the feasibility study. (See also W90-04234) (Lantz-PTT)
W90-04239

LEVEL OF DETAIL IN RECONNAISSANCE REPORTS.
B. Fowler.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 69-78.

Descriptors: *Nonstructural alternatives, *Flood plain management, *Reconnaissance studies, Communication, Information exchange, Hydrology, Hydraulics.

This paper addresses the nature of the reconnaissance decision, what should be done in support of that, and techniques or strategies that can assist in obtaining data and analyses which provide a 'good enough' foundation for that decision. Still, no definitive guidance on the appropriate level of detail is provided, and some may find that unsatisfactory. Varying degrees of uncertainty and the particular 'uniqueness' of each study situation make hard and fast degree of detail guidance quite difficult to define. Recommendations resulting from feasibility and reconnaissance studies vary in the degrees that utilize and depend on information provided by Corps of Engineers functional elements. Recons are unusual in that they are driven, essentially, by the economics and the hydrology-hydraulics. Communication between hydrology and economics is essential to efficient formulation and evaluation. Formulation is part are to begin with: formulation with an eye toward an efficient study process, one that gets answers good enough to make good decisions about feasibility studies requires collaborative art. Documentation is the principal means by which official communication among Corps of Engineer Districts, higher authorities, and sponsors take place, and must necessarily be the major information base for decision making. The importance of a good written 'record of decision'--which each recon report is--can hardly be overestimated, particularly as the level of decision making is elevated. (See also W90-04234) (Lantz-PTT)
W90-04240

ANALYTICAL METHODS AND TOOLS FOR RECONNAISSANCE-PHASE STUDIES.
Hydrologic Engineering Center, Davis, CA. Planning Div.
For primary bibliographic entry see Field 7B.
W90-04241

PLAN FORMULATION STRATEGY--KAWEAH CASE STUDY.
Army Engineer District, Sacramento, CA. Special Studies Branch.
M. A. Squires.
IN: Proceedings of a Seminar on Flood Damage

Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 95-105, 1 fig, 2 tab.

Descriptors: *Nonstructural alternatives, *Flood plain management, *Risk assessment, Kaweah River, Case studies, Decision making, Economic aspects, Cost-benefit analysis, Cost sharing.

The Kaweah River Basin Investigation serves as a prime example of how plan formulation strategy has changed as a result of new study cost sharing requirements. These new cost sharing requirements for feasibility studies have, of necessity, led the potential study sponsor into actively participating in project formulation strategy during the reconnaissance phase of study. It is to the sponsor's advantage to insure that study efforts during the cost shared feasibility studies focus on locally supported project alternatives. The major project formulation decisions are made by the locals during the reconnaissance phase of study as soon as the preliminary benefit-to-cost ratios are developed. The locals' financial commitment to study funding for feasibility is only made after they feel confident that there is an acceptable and implementable project being offered. The Corps of Engineers does not have this type of strong financial commitment toward a project until the feasibility study phase has been completed and the project is authorized by Congress. Flood risk is a very difficult concept to convey to local interests. High flows and threatened flooding in recent years does not impress them--flooding is too easily seen as a small risk and forgotten. More visible annual benefits, water supply for instance and sometimes recreation, are more readily recognizable benefits and therefore tend to be supported by the local communities. Based on the dynamics of formulation that will develop after the feasibility cost sharing agreement has been signed, it is necessary to scope the project design studies so that features such as varying tunnel diameters, gates for outlet works, and smaller or larger dam sizes can be added or deleted as needed. (See also W90-04234) (Lantz-PTT)
W90-04242

STUDY MANAGEMENT BLUE RIVER BASIN CASE STUDY.
N. Tester.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 107-116, 1 fig, 2 tab.

Descriptors: *Nonstructural alternatives, *Blue River, *Case studies, *Flood plain management, Flood protection, Indian Creek, Kansas City, Levees, Economic aspects, Flood control, Missouri, Kansas.

The Blue River, a right bank tributary of the Missouri River, drains a predominantly urban area of 272 sq mi. It flows northeasterly, entering Kansas City, Missouri at the state line, continuing to the Missouri River confluence at mile 358. It has an average annual discharge of 146 cu ft/sec (cfs). Brush Creek and Indian Creek are the principal tributaries. The flood problems on the Blue River and Indian Creek have been well documented over the past 27 years. The reconnaissance study was initiated in January 1986, when $200,000 in funds were allocated to the Kansas City District, Corps of Engineers (Corps). Technical data were available from numerous sources, but mapping in the Kansas City, Missouri portion of the study area required updating. Aerial photography was flown in February 1986 and the mapping products were made available in June. The delay of this vital data attenuated plan formulation, and study completion. The cost sharing requirement for the feasibility study dictated that flood damage reduction solutions must be developed not only to be economically efficient, environmentally and politically acceptable, but must also be located in jurisdictions capable of financing the feasibility study. The study concluded that: (1) flooding within the study area is most severe along Indian Creek in Overland Park, Leawood, and Kansas City, and along the Blue River from Prospect Ave to 75th St. Plans to reduce flooding in these areas appear to be economically feasible and environmentally acceptable; (2) the levee plan for Mission Rd at Leadwood, Kansas appears to be technically and economically feasible, but has been eliminated from further consideration in the feasibility phase studies due to a lack of Federal interest. Recent Administration policy interpretation requires Federal flood control studies to emphasize reducing flood damages for existing development. Since a large portion of benefits at the Mission Rd location involve intensification of land use and projected development, it is concluded that Federal participation in that area is not warranted at this time; and (3) Overland Park and Kansas City are potential Non-Federal sponsors of a feasibility study. Both cities have the legal authority and the desire to sponsor a feasibility phase study. (See also W90-04234) (Lantz-PTT)
W90-04243

RECONNAISSANCE STUDY FOR OVERLAND PARK.
Overland Park, KS.
P. D. Piatt.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 117-128, 4 fig.

Descriptors: *Flood forecasting, *Rainfall-runoff relationships, *Nonstructural alternatives, *Reconnaissance studies, *Flood plain management, Kansas, Indian Creek, Information exchange, Overland Park, Computer models, Cost-benefit analysis, Sewers.

Overland Park is a rapidly growing suburb of Kansas City, Missouri. Overland Park has grown rapidly over the past few years. Office and commercial development, resulting in construction of quality homes and apartments have made Overland Park a community of well above average income, as well as high expectations for public services. A large portion of the recent development has been in the Indian Creek drainage basin, resulting in rapid rises in the creek in the higher frequency rainfall events. In June of 1984, a serious flood occurred on Indian Creek. In the 1984 event rainfall typically was eight inches over most of the Indian Creek watershed. Flooding occurred along the entire length of Indian Creek. The City entered into an agreement to study flood flows on Indian Creek and to make recommendations on flood control methods. The study was completed in November of 1986. Highlights of the report included discussions about: (1) information exchange; (2) delays; (3) cost-benefit analyses; (4) technical differences--computer modeling; (5) accuracy; and (6) construction of sanitary sewers. (See also W90-04234) (Lantz-PTT)
W90-04244

MANAGEMENT OF RECONNAISSANCE PHASE STUDIES.
Corps of Engineers, Baltimore, MD. Baltimore District.
For primary bibliographic entry see Field 7A.
W90-04245

RECONNAISSANCE PHASE STUDIES--A DIVISION PERSPECTIVE.
Corps of Engineers Lower Mississippi Valley Div., New Orleans, LA. Planning Div.
For primary bibliographic entry see Field 7A.
W90-04246

FLOOD HYDROGRAPH AND PEAK FLOW FREQUENCY ANALYSIS.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 4A.
W90-04309

PRACTICES AND PROBLEMS IN FLOOD PLAIN MANAGEMENT.
Urban Drainage and Flood Control District, Denver, CO.
L. S. Tucker.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 333-341.

Descriptors: *Urban hydrology, *Urban runoff, *Flood plain management, *Flood plains, *Flood hazard, Land use, Urbanization, National Flood Insurance Program, Land use, Maintenance, Flood control, Economic aspects.

Most flood plain management problems are the result of existing or potential encroachment on nature's prescriptive drainage easements. Most of these existing or potential encroachments are related to urbanization and the pressure to develop available open land. The basic objective of flood plain management is to reduce flooding damages in developed flood plains and prevent problems in undeveloped flood plains. Individual practices of flood plain management have been categorized to fall into three basic approaches or strategies as follows: (1) modifying the susceptibility to flood damage and disruption; (2) modifying the floods themselves; and (3) modifying the flood impact on the individual and the community. The main problems are: balkanization or fractionalization of urban areas whereby there is no regional policy; the National Flood Insurance Program of the Federal Insurance Administration, which basis its rates on present risks, not potential future risks; lack of flood hazard awareness by the public, involving floodproofing, flood warnings, hazards, and insurance; lack of Federal commitment regarding small urban watersheds; flood plain acquisition and maintenance of flood plains and facilities; Federal project authorization procedures, whereby Corps of Engineer projects from the planning stage to authorization by Congress is a minimum of 10 years; and, financing drainage, flood control, and detention storage. (See also W90-04398) (Lantz-PTT)
W90-04331

LOCALLY IMPORTANT ECONOMIC CONSIDERATIONS IN FLOODING AND FLOOD PLAIN MANAGEMENT.
D. E. Jones.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 352-374, 4 fig, 2 tab, 11 ref.

Descriptors: *Local governments, *Federal jurisdiction, *Flood damage, *Regulations, *Flood plain management, *Economic aspects, Flood hazard, Flood flow, Flow velocity, Flood peak.

Federal statute establishes an appeals process whereby local governments can appeal elevations proposed by the Secretary of Housing and Urban Development with respect to an identified area of special flood hazards. Appeals must focus upon the scientific or technical correctness of the elevations established. Unfavorable Secretarial decisions regarding appeals may in turn be appealed to the United States district court for the jurisdiction. Whether or not appeal of the Federal determinations is warranted, State and local governments should strive to evolve regulatory measures that treat property owners and their unique local situations equably. Federal authority and postures are tightly constrained by Federal statutes and related implementing regulations, but local government flood plain management actions are not. Under special local conditions: (1) different kinds of buildings suffer significantly different amounts of damage during flooding; (2) the depth-frequency flooding relationships at different locations can result in significantly different average levels of flooding damage; (3) the relative scale of the potential extent of local flooding can foreseeably increase post-flood repair costs by as much as several hundred percent; and (4) that flood damage directly attributable to velocity of flood flow also will aggravate flooding losses at some locations. Evaluations of the comparative combined effects of these damage variables indicates that actions taken at one location may coincide in effect with

those taken at other places, but is also indicates that comparison of conditions having the greatest contrast may reveal effects of regulation that are up to 25 or more times greater at one location than at another. It is clear that State and local governments have a basic responsibility to their consistencies to assure that their own regulations have consistent effects throughout their jurisdiction. (See also W90-04398) (Lantz-PTT)
W90-04333

ALTERNATIVES FOR STANDARDS AND REGULATIONS.
Federal Insurance Administration, Washington, DC.
B. R. Mrazik, and R. W. Krimm.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 375-386, 8 ref.

Descriptors: *Regulations, *Flood plain management, *Insurance, Flood hazard, Federal jurisdiction, Local governments.

Early objectives of the National Flood Insurance Programs were the rapid identification of flood prone communities, determination of regulatory elevations and risks through rate studies, and conversion of communities the Regular Flood Insurance Program to assure compliance with more comprehensive standards and regulations. Presently, virtually all flood prone communities have been identified and more than 90% of the population at risk will have rate studies completed within the next two years. The Program is now being redirected to provide greater community assistance in administration of program requirements at the local level. With greater emphasis on community assistance, the Federal Insurance Administration will be better prepared to adapt the standards and regulations of the Program to meet local needs and situations. Evolution of the Program standards and regulations will likely occur in three primary directions, including greater recognition of variable types of hazards, local socio-economic situations, and natural and beneficial floodplain values. (See also W90-04398) (Lantz-PTT)
W90-04334

PROBLEMS OF STORMWATER RUNOFF AND FLOOD MANAGEMENT.
Urban Drainage and Flood Control District, Denver, CO.
L. S. Tucker.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 56-59.

Descriptors: *Urban hydrology, *Water pollution control, *Flood control, *Storm runoff, *Urbanization, *Urban runoff, Erosion control, Construction, Flood plain management, Flooding, Surface runoff, Urban hydrology, Nonstructural alternatives, Storm water.

There are common flood problems in spite of local differences which affect urbanizing and urbanized areas across the country. Different problems are associated with the three major components of stormwater systems, namely, surface runoff, transport, and receiving waters as they relate to the transitional and developed phases of urbanization. During the transitional phase, the following six problems are encountered: (1) construction-related erosion; (2) minor flooding of physical facilities due to a lack of collector systems, their poor design, or incomplete systems; (3) flood plain encroachment caused by economic pressure to maximize use of available land in order to increase rate of return on investment; (4) excessive sediment in receiving waters, caused by erosion from construction activities; (5) erosion of stream beds and banks, which is a natural process aggravated by increased flows created by urbanization and by channelization and straightening of streams; and (6) damage to highways, roads, bridges and culverts, caused by increased flows and/or inadequate crossings. In developed areas, because of increased flood runoff and occupation of the flood plain, there is flooding of urban areas from streams, creeks and rivers. A primary surface runoff problem in developed areas is inconvenience type flooding, caused by facilities in the way of overland flow. There are also problems with construction erosion, similar to those encountered during the transitional phase. In fully developed areas, minor flooding of physical systems often occurs. Causes include inadequate collector systems, inadequate inlets, and increased runoff due to upstream development. A stormwater runoff related problem in developed areas is the pollution of receiving waters. Development of solutions to this problem at prices that can be afforded will require probably a 10-20 year process of data collection and analysis and of identification, and evaluation of both structural and non-structural solutions. Degradation of urban streams can result from a lack of maintenance. Needed to address this problem are commitment of financial resources, assured access to the streams and development of multiple purpose uses. (See also W90-04338)(Lantz-PTT)
W90-04345

CORPS OF ENGINEERS URBAN STUDIES PROGRAM.
Corps of Engineers, Waltham, MA. Basin Management Branch.
L. J. Bergen.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 60-63.

Descriptors: *Urban hydrology, *Water pollution control, *Urban areas, *Flood control, *Urbanization, Research priorities, Water quality control, Flood damage, Economic aspects.

Urban centers are faced with critical water resources problems arising from within the urbanized areas themselves. The Corps of Engineers Urban Studies Program is an element of the Civil Works Program structured to provide a multi-lateral approach to planning, one that encompasses all elements of water resources management. Within the New England area, two studies under this Urban Studies Program have been completed. They are the Merrimack Wastewater Program and the eastern Massachusetts Metropolitan Area Study, both of which were wastewater oriented. Two more urban studies underway are for the Housatonic River Basin in western Massachusetts and Connecticut, and for a large segment of eastern Massachusetts and essentially all of Rhode Island. These two studies are dealing with problems of flood management, water supply, regional recreation, and navigation. Review of selected flood management studies across the country, indicates some interesting trends: (1) Evacuation and relocation of structures are difficult unless frequency of flooding is great enough to convince people of the danger; (2) Flood damage reduction alone is seldom sufficient to justify costs of non-structural measures; and (3) The extent of Federal interest is limited, therefore, requiring a concerted involvement of non-Federal entities. The project needs to be high on the list of non-Federal priorities for investment of time and money, because project implementation often requires the coordination of all available funding programs. (See also W90-04338)(Lantz-PTT)
W90-04346

CONTROL OF URBAN RUNOFF AND NON-POINT SOURCE POLLUTION.
Massachusetts Univ., Amherst. Water Resources Research Center.
For primary bibliographic entry see Field 5G.
W90-04348

FLOOD INSURANCE AND FLOOD PLAIN ZONING.
Denver Urban Drainage and Flood Control District, CO.
L. S. Tucker.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 271-286, 1 ref.

Descriptors: *Urban hydrology, *Water pollution control, *Insurance, *Flood plain zoning, *Urban areas, *Nonstructural alternatives, Regulations, Urbanization, National Flood Insurance Program, Research priorities, Flood plain management.

A review of the National Flood Insurance Program (NFIP) concluded that sufficient progress is being made that both regulation and insurance should be continued. The regulatory program in already-developed flood plains has had a limited effect on flooding, erosion control, and water supply. In developing flood plains, the results have been more successful. Persistent problems with respect to flood plain protection include: (1) the lack of awareness of flood problems by residents; (2) lack of adequate data on numbers of people living in flood plains, how many are aware they do, and other questions related to the overcoming of perception-awareness-resistance problems; (3) the effectiveness of flood plain regulation; (4) difficulty in the administration of effective local programs in the face of local political problems; and (5) definition of flood plains using existing hydrology when future flows will be greater due to urbanization. Results with the NFIP, although generally successful, were mixed. Ways have not been found to manage risk in the fringe areas where there is no NFIP. Some 30-50% of flood damage may be in these areas. A number of additional problems needing attention include: (1) the slow rate of NFIP mapping; (2) the need for more economics in analyzing alternatives; (3) the considerable differences between communities and among house types; (4) an answer to the question concerning the needed levels of flood risk reduction; and (5) need for alternative approaches such as seed money to purchase equities of flood prone properties. (See also W90-04338)(Lantz-PTT)
W90-04366

PLANT FLOW REDUCTIONS AND OUTAGES AS MITIGATIVE MEASURES.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
T. L. Englert, J. Boreman, and H. Y. Chen.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 274-279. 2 tab, 11 ref.

Descriptors: *Hudson River Estuary, *Thermoelectric powerplants, *Nuclear powerplants, *Estuarine fisheries, *Environmental effects, Entrainment, Mathematical models, Cooling towers, Ichthyoplankton, Mortality, Alteration of flow.

The component of the Hudson River settlement agreement that was subjected to the most detailed technical analysis and received central attention during the settlement negotiations was the schedule for reductions in cooling water flow rates and outages for maintenance and refueling at the power plants. Factors considered in the development of such a schedule included possible increases in thermal mortality of ichthyoplankton as a result of flow reductions, plant-by-plant timing of flow reductions and outages to achieve maximum reduction of entrainment mortality, and costs of outages and their effect on system reliability. A mathematical model based on empirical spatiotemporal distributions of ichthyoplankton was used to evaluate the effectiveness of alternative schedules in reducing entrainment mortality of striped bass, white perch, river herrings, Atlantic tomcod, and bay anchovy. In conjunction with the other considerations identified above, the model output was used to develop a set of flow reductions and plant outages that mitigated entrainment impact at acceptable cost and allowed utilities to meet electric power demands. The reductions in entrainment mortality associated with various plant outages were used to develop a system of cross-credits that allowed the utilities as a group to receive credit for unscheduled outages at any of the plants. The

model results also provided the basis for a point system to determine whether or not the utilities have met specified goals for outages over the life of the settlement agreement. (See also W90-04505) (Author's abstract)
W90-04525

6G. Ecologic Impact Of Water Development

EFFECT OF BOAT TRAFFIC ON RIVER REGIME.
Forth River Purification Board, Edinburgh (Scotland).
For primary bibliographic entry see Field 2E.
W90-03657

HISTORICAL CHANGE OF LARGE ALLUVIAL RIVERS: WESTERN EUROPE.
For primary bibliographic entry see Field 2E.
W90-03689

HISTORICAL ANALYSIS OF FLUVIAL HYDROSYSTEMS.
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03690

IMPACT OF 18TH AND 19TH CENTURY RIVER TRAINING WORKS: THREE CASE STUDIES FROM SWITZERLAND.
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
For primary bibliographic entry see Field 2E.
W90-03691

HYDROLOGICAL CHANGES OF THE RHONE RIVER.
Grenoble-1 Univ. (France). Lab. de la Montagne Alpine.
For primary bibliographic entry see Field 2E.
W90-03693

PALEOECOLOGICAL ANALYSES OF LARGE RIVERS: SOME PRINCIPLES AND METHODS.
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
For primary bibliographic entry see Field 2E.
W90-03698

LOWER RHINE GEOMORPHOLOGICAL CHANGES.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 2E.
W90-03699

LOWER RHINE: PALAEOECOLOGICAL ANALYSIS.
Klink Hydrobiological Consultants, Wageningen (Netherlands).
For primary bibliographic entry see Field 2E.
W90-03700

CHANGES IN FISH STOCKS AND FISHERIES: THE LOWER ELBE RIVER.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 2E.
W90-03701

HISTORICAL CHANGES OF THE GARONNE RIVER, SOUTHERN FRANCE.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 4A.
W90-03704

RECENT HISTORICAL CHANGES ON THE BELGIAN MEUSE.
Facultes Universitaires Notre-Dame de la Paix, Namur (Belgium). Unite d'Ecologie des Eaux Douces.
J.C. Micha, and M. C. Borlee.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 269-295. 9 fig, 5 tab, 47 ref.

Descriptors: *Meuse River, *Ecological effects, *Flood plain management, *River basin development, *History, Radioactive wastes, Thermal pollution, Chemical wastes, Nuclear powerplants, Channels, Catchment areas, Suspended sediments, Ecosystems, Hydrologic aspects, Eutrophication, Flow rates, Physicochemical properties, Macroinvertebrates, Macrophytes, Belgium, Water pollution effects.

The Meuse River flows through three main countries: France, Belgium, and the Netherlands. Forty percent of its catchment area is in Belgium. When a nuclear power station was installed on the Meuse in central Belgium, the impact of thermal, radioactive, and chemical waste on the water of the Meuse and on its biocenoses was studied. Three successive periods of development of the channel bed and the flood plain in Belgium have occurred, and their hydrological, physicochemical, and ecological consequences have been examined. Since the last century, the ecosystem of the Meuse has undergone, due to the increasing activity of man, modifications of increasing importance: marked reduction of the water flow, a drastic increase in the suspended material being transported, a degree of eutrophication of the water, and the disturbance of the original floral and faunal communities. The causes of this evolution of the Meuse can be itemized as different types of human interference in descending order of importance: (1) occupation of the catchment area; (2) encroachment on the flood plain; (3) encroachment on the channel bed; (4) destruction of habitats; (5) water pollution; (6) overexploitation of fish-breeding stocks; and (7) introduction of foreign species. Thought should be given to restoring damaged sectors by recreating shallow riverside zones suitable for aquatic macrophytes, for the macroinvertebrates which are linked to them, and for the reproduction of many species of fish. The example of human interference on the Meuse reveals the necessity of taking into account environmental problems; this would involve a global policy of economic-ecological management. (See also (W90-03689) (Fish-PTT)
W90-03705

HISTORICAL CHANGES OF THE RIVER WESER.
Wasserwirtschaftsamt Bremen (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W90-03706

ECOLOGICAL CHANGES OF THE FRENCH UPPER RHONE RIVER SINCE 1750.
Lyon-1 Univ., Villeurbanne (France). Lab. d'Ecologie des Eaux Douces.
For primary bibliographic entry see Field 4A.
W90-03707

ASSESSMENT OF BUFFALO FISHERIES RESOURCES IN A MISSISSIPPI STREAM THREE DECADES AFTER CHANNELIZATION.
Mississippi State Univ., Mississippi State. Dept. of Agricultural and Biological Engineering.
D. C. Jackson, and J. R. Jackson.
IN: Proceedings of the Nineteenth Mississippi Water Resources Conference. Water Resources Research Institute, Mississippi State University, Mississippi State, MS. 1989. p 1-4. 2 fig, 3 tab, 13 ref.

Descriptors: *Environmental effects, *Channeling, *Mississippi, *Flood control, *Fish populations, *Stream fisheries, *Buffalo fish, Fisheries, Population distribution, Population dynamics, Growth, Yazoo River, Gar, Sport fishing.

With few exceptions, streams in the Yazoo River basin of western Mississippi have been channelized. As a result of these federal flood control projects, fewer than about 20% of the stream reaches in the basin were capable of supporting a fishery of any kind with even fewer reaches supporting sport fisheries. The population structure of buffalo fish stocks and their status as exploitable resources in the Yalobusha River, one of the principal tributaries of the Yazoo River, were determined, three decades after the original channelization of the river. Three species of buffalo fish were collected from the Yalobusha River during this investigation: bigmouth buffalo (Ictobus cyprinellus), black buffalo (Ictiobus niger), and smallmouth buffalo (Ictiobus bubalus). The mean catch (all fish species) was 2.79 kg/net-night of which three buffalo species collectively contributed 45%. Gar (Lepisostedidae) were the only other major component of the catch (24%). Bigmouth buffalo stocks appeared better structured for exploitation purposes than did smallmouth buffalo stocks. Although resources capable of supporting traditional artisanal/subsistence buffalo fisheries were present in the Yalobusha River, age and growth parameters, mean weights and structural indices of fish captured, suggested that the fisheries resources in this stream were overcrowded and stunted. In those reaches of the Yalobusha River impacted by channelization, it is unlikely that artisanal and/or subsistence fisheries will become re-established in the foreseeable future. (See also W90-03708) (Friedmann-PTT)
W90-03709

OECD ENVIRONMENTAL DATA: DONNEES OCDE SWR L'ENVIRONMENT, COMPENDIUM 1989.
Organization for Economic Co-Operation and Development, Paris (France).
For primary bibliographic entry see Field 10C.
W90-03742

BIOLOGY OF THE YUMA CLAPPER RAIL IN THE SOUTHWESTERN U.S. AND NORTHWESTERN MEXICO.
Wyoming Cooperative Fishery and Wildlife Research Unit, Laramie.
W. R. Eddleman.
Final Report, July 1989. Fish and Wildlife Service Contract 4-AA-30-02060.

Descriptors: *Water birds, *Endangered species, *Habitat restoration, Mittry Lake, Crystal Beach Marsh, Yuma Clapper Rail, Marshes, Mexico, Water level fluctuations, Seasonal variation, Wildlife, Crayfish.

The biology of the Yuma clapper rail was studied at Mittry Lake Wildlife Management Area and Crystal Beach Marsh from February 1985-December 1987. Aspects considered by the study included migration and wintering patterns, general life history, habitat use patterns, foods and seasonal availability of major prey, and the usefulness of the call count survey. A total of 122 Yuma clapper rails was captured using combinations of drift fences and traps and female solicitation tapes. Ninety-nine birds were fitted with radio transmitters to study migratory behavior and seasonal movements. Home range of Yuma clapper rails averaged > 7 ha, and was larger after the breeding season and during the winter. Nearly all birds concentrated their activity in core use areas that approximated previous estimates of territory size. Emergent marsh vegetation types were selected by rails in most habitat situations. When high water prevailed at Crystal Beach, birds selected higher sites dominated by willow, salt cedar, or upland edge vegetation. After breeding and in winter, birds at Mittry Lake increased their use of salt cedar stands for unknown reasons. Yuma clapper rails selected microhabitats with less coverage by vegetation, less residual mat of dead vegetation, less bare ground, more coverage by water, proximity to habitat changes, shallower water, and higher stem densities than were present at randomly selected sites. A well-developed residual mat could compensate for deep water. To further promote recovery of the Yuma clapper rail, additional areas need to be managed for the species. Managed units should be protected from sudden changes in water depth,

both from flooding and from drying so a reliable water supply would be available. (Lantz-PTT)
W90-03800

HOHOKAM ARCHAEOLOGY ALONG PHASE B OF THE TUCSON AQUEDUCT CENTRAL ARIZONA PROJECT. VOLUME 1: SYNTHESES AND INTERPRETATIONS, PART I.
Arizona State Museum, Tucson. Cultural Resource Management Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-115791. Price codes: A12 in paper copy, A02 in microfiche. Archaeological Series 178, Volume 1, Part 1, 1989. 244p, 34 fig, 59 tab, 248 ref, 4 append. Bureau of Reclamation Contract 6-CS-30-03500. Edited by Jon S. Czaplicki and John C. Ravesloot.

Descriptors: *Archaeology, *Hohokam Indians, *Water resources development, *Arizona, Tucson Aqueduct.

The first of five volumes that report on the Tucson Aqueduct Phase B Project presents syntheses and interpretations of the analyses that resulted from the investigation of 13 Hohokam sites in the Avra Valley west of Tucson, Arizona. The Tucson Aqueduct Phase B project involved excavation or surface collection and mapping of 13 sites including Fastimes, a collection of at least five Hohokam farmsteads; two farmstead-field house sites; a probable protohistoric site; four limited activity sites; and four quarry sites. Volume 1, Part 1, contains chapters 1 through 7 which discuss the project design, the influence of the landscape on Hohokam settlement patterns in Arizona, excavation methods, faunal remains at four sites, and an assessment of Hohokam subsistence based on the pollen record. (See W90-03802 and W90-03803) (Lantz-PTT)
W90-03801

HOHOKAM ARCHAEOLOGY ALONG PHASE B OF THE TUCSON AQUEDUCT CENTRAL ARIZONA PROJECT. VOLUME 1: SYNTHESES AND INTERPRETATIONS, PART II.
Arizona State Museum, Tucson. Cultural Resource Management Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-115809. Price codes: A12 in paper copy, A02 in microfiche. Archaeological Series 178, Volume 1, Part 2, 1989. 252p, 36 fig, 22 tab, 353 ref. Bureau of Reclamation Contract 6-CS-30-03500. Edited by Jon S. Czaplicki and John C. Ravesloot.

Descriptors: *Archaeology, *Hohokam Indians, *Water resources development, *Arizona, Tucson Aqueduct.

The first of five volumes that report on the Tucson Aqueduct Phase B Project presents syntheses and interpretations of the analyses that resulted from the investigation of 13 Hohokam sites in the Avra Valley west of Tucson, Arizona. The Tucson Aqueduct Phase B project involved excavation or surface collection and mapping of 13 sites including Fastimes, a collection of at least five Hohokam farmsteads; two farmstead-field house sites; a probable protohistoric site; four limited activity sites; and four quarry sites. Part 2 of Volume 1 contains chapters 8 through 15 which discuss the macrofloral evidence of pre-classic Hohokam subsistence in the Tucson Aqueduct Project Phase B area, the local and regional organization and interaction, chemical composition of pottery, the design of colonial period pottery, an analysis of Hohokam flaked-stone, modeling of prehistoric behavior from the analysis of ground-stone assemblages, and late pioneer and colonial period shell. (See W90-03801 thru W90-03803) (Lantz-PTT)
W90-03802

HOHOKAM ARCHAEOLOGY ALONG PHASE B OF THE TUCSON AQUEDUCT CENTRAL ARIZONA PROJECT. VOLUME 3: EXCAVATIONS AT WATER WORLD (AZ AA:16:94), A RILLITO PHASE BALLCOURT VILLAGE IN THE AVRA VALLEY.
Arizona State Museum, Tucson. Cultural Resource Management Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-115817, Price codes: A15 in paper copy, A02 in microfiche. Archaeological Series 178, Volume 3, 1989. 327p, 48 fig, 55 tab, 101 ref. Bureau of Reclamation Contract 6-CS-30-03500. Edited by Jon S. Czaplicki and John C. Ravesloot.

Descriptors: *Archaeology, *Hohokam Indians, *Water resources development, *History, *Arizona, Tucson Aqueduct.

During 1986 and 1987 a Rillito phase Hohokam settlement that lay in the right-of-way for the Tucson Aqueduct Phase B, Central Arizona project was excavated. Known as Water World (AZ AA:16:94 ASM), the site is located at the southern end of the Avra Valley on the distal end of a lower bajada of the Tucson Mountains. One hundred forty-seven features were identified by backhoe trenching and surface stripping, including 45 structures. Fifty-nine features were investigated: 21 structures, a ballcourt, 14 pits or hearths, 21 cremations, a midden deposit, and potbreak. The features were divided into seven house groups, a ballcourt area, and a possible central plaza. Water World is located in a nonriverine environment where floodwater farming potential should have been very good. There are, however, hints that agriculture may not have been as intensively practiced as expected. (See W90-03801 thru W90-03803) (Lantz-PTT)
W90-03803

EFFECTIVENESS AND ENVIRONMENTAL IMPACTS OF IRRIGATION PROJECTS: A REVIEW.
For primary bibliographic entry see Field 3F.
W90-03808

PALEOENVIRONMENTS AND ARCHAEOLOGY OF THE TRIGO MOUNTAINS: DATA RECOVERY IN THE HART MINE AND CIBOLA QUARRY AREAS, YUMA COUNTY, ARIZONA.
Statistical Research, Tucson, AZ.
S. D. Shelley, and J. H. Altschul.
Gray Literature Press, Tucson, AZ. 1989. 141p, 25 fig, 24 tab, 88 ref, append. Bureau of Reclamation Contract 7-SQ-30-12550.

Descriptors: *Arizona, *Archaeology, *Water resources development, Colorado River, Trigo Mountains, History.

The results of data recovery conducted for the Bureau of Reclamation, Lower Colorado Region at six prehistoric sites in the Hart Mine and Cibola Quarry areas are presented. The Bureau of Reclamation plans to use the Hart Mine and Cibola Quarry areas to mine riprap for use along the Colorado River. The project area is located at the base of the Trigo mountains about 20 miles south of Ehrenberg, Arizona. Three of the sites are composed primarily of lithic debitage and cores. These sites are associated with an alluvial terrace upon which, among other raw materials, a substantial amount of rhyolite was deposited. This terrace has been visited by people who have specifically focused on testing and extracting quality pieces of rhyolite at least since the Archaic Period. Little change over time is noted in the lithic technology. The three remaining sites are all located in concealed caves in the mountains. These sites are interpreted caches that were used during the Ceramic or Protohistoric periods. The caches appear to consist of one or a few ollas that were filled with corn meal. In two caches the ollas had been placed behind rock walls in small, unobtrusive alcoves. Hypotheses are presented about the possible role of the caches. A review of the evidence suggests that the most likely hypotheses are that the caches were used by small groups of hunters for emergency food, or as safe food or seed storage by familial groups insuring against the deprivations of raids. The most surprising finds of the project are three packrat middens found on top and at the base of one of the rock walls hiding an olla cache. The middens date to between 11,000 and 7,000 B.P. Although not related to cultural behavior, paleobotanical analysis of the middens reveals that this section of the Colorado River Valley supported a large, dense mesquite bosque during this period. These data are the first of this age to be obtained from a low elevation site along the lower portion of the Colorado River. (Author's abstract)
W90-03828

LAKE BUHI: RESOLVING CONFLICTS IN A PHILIPPINE DEVELOPMENT PROJECT.
International Inst. for Environment and Development, London (England).
G. Conway, P. Sajise, and W. Knowland.
AMBIO AMBOCX, Vol. 18, No. 2, p 128-135, 1989. 8 fig, 3 tab, 13 ref.

Descriptors: *Workshops, *Dam effects, *Water level fluctuations, *Lake fisheries, *Multiobjective planning, *Water supply development, Public participation, Flooding, Priorities, Commercial fishing, Ecosystems, Philippines.

The construction of a small dam at the outlet of Lake Buhi in the Bicol province of the Philippines created a number of problems that threatened the livelihood and wellbeing of the local inhabitants. These included damaged ricelands, drying out of fish cages, loss of river navigational routes, and drying up of shallow town wells, and were all due to lake water level fluctuations. In order to resolve these problems, a workshop was held in the area using the technique of Agroecosystem Analysis. Participants were representatives of the donor and government agencies, officials of the municipality of Buhi, and the local farmers and fishermen. The technique proved to be an efficient and economic way of achieving a consensus of priorities for further action. There was a general agreement that many of the problems of the Buhi area were greatly compounded by lack of information and misinformation. In this respect, the workshop also proved to be of considerable value. (Author's abstract)
W90-04006

MAN'S IMPACT ON THE ECOSYSTEM OF THE BALTIC SEA: ENERGY FLOWS TODAY AND AT THE TURN OF THE CENTURY.
Stockholm Univ. (Sweden). Dept. of Zoology.
R. Elmgren.
AMBIO AMBOCX, Vol. 18, No. 6, p 326-332, 1989. 3 fig, 4 tab, 74 ref.

Descriptors: *Eutrophication, *Water pollution effects, *Baltic Sea, *Marine fisheries, *Aquatic productivity, Zooplankton, Seals, Food chains.

The impact of man on the Baltic ecosystem in the 20th century is summarized by estimating changes in major energy flows, expressed as organic carbon. Recent eutrophication has increased pelagic primary production by an estimated 30-70%, and sedimentation of organic carbon by 70-190%. Above the primary halocine, biomass and production of benthos have increased, while in the deep waters of the Baltic proper, oxygen deficiency has lead to the loss of formerly important food chains over nearly 100,000 square km of the bottom. The net result is an approximate doubling of macrobenthic production, but little increase in meiobenthic production. Zooplankton production is thought to have increased less than primary production, perhaps by about a quarter. Fish catches in the Baltic have increased more than tenfold, but this is considered to be due only partly to increased fish production caused by more food for fish. Increased fishing effort and the near extermination of fish-eating Baltic seals, through hunting and pollution, are likely to be equally important. Today, the Baltic fishery requires about 10% of the primary production in the Baltic to produce its catches, whereas the remnant seal population needs less than 0.1%. At the beginning of this century the fishery required about 1% and the marine mammals an estimated 5% of the primary production. (Author's abstract)
W90-04081

STOCHASTIC MODEL TO EVALUATE RIPARIAN IRRIGATION EXPANSION IN THE EASTERN UNITED STATES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 3F.
W90-04198

ECOLOGY OF ATLANTIC WHITE CEDAR WETLANDS: A COMMUNITY PROFILE.
Marine Biological Lab., Woods Hole, MA.
For primary bibliographic entry see Field 2H.
W90-04255

ENERGY FROM THE WEST: IMPACT ANALYSIS REPORT. VOLUME I: INTRODUCTION AND SUMMARY.
Oklahoma Univ., Norman. Science and Public Policy Program.
For primary bibliographic entry see Field 4C.
W90-04256

1987 SAVANNAH RIVER CURSORY SURVEYS.
Academy of Natural Sciences of Philadelphia, PA. Div. of Environmental Research.
For primary bibliographic entry see Field 2H.
W90-04268

ENERGY FROM THE WEST: SUMMARY REPORT.
Oklahoma Univ., Norman. Science and Public Policy Program.
For primary bibliographic entry see Field 6D.
W90-04269

ENVIRONMENTAL INFORMATION FROM SEDIMENTS.
Geological Survey, Menlo Park, CA. Geologic Div.
D. P. Adam.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 206-219, 6 fig, 7 ref.

Descriptors: *Sediment analysis, *Environmental quality, *Paleontology, *Paleohydrology, Biological studies, Physical analysis, History, Chlorophyll, Amino acids, Pigments, Geochemistry, Biochemistry.

To predict how both natural and man-modified water resources are likely to behave in the future, such forecasts should be based on a knowledge of present and past behavior. Because instrumental data are not adequate for long-term predictions, such records must be supplemented by long-term data from historical records, tree rings, and other proxy data that provide only indirect records of past hydrologic behavior. Proxy data may often be obtained from sediments. Among continental environments, lakes and marshes are particularly suitable for study because they act as sediment traps. Under favorable conditions, sediment may accumulate more or less continuously in a given spot for thousands of years, initially including whatever happens to be washed in, blown in, or chemically precipitated, including both mineral grains and biological remains. Physical evidence for past hydrologic behavior may be found in grain size distributions and in mineralogy. Studies of organic remains in sediments are diverse, and most workers specialize in one or a few types of remains. Many workers recognize an informal distinction between microfossils and macrofossils. Microfossils include pollen and spores and various kinds of algae, including diatoms, chrysomonads, Pediastrum, Botryococcus, and Coelastrum. Macrofossils include remains of both plants and animals. Animal remains include fish bones and scales, teeth and bones of small mammals, gastropod and ostracod shells as well as insects. Plant remains are usually seeds, leaves, or wood. An important aspect of plant macrofossils is their carbon content which may permit radioactive dating. In addition to macrofossils and microfossils, there are also biogeochemical indicators of past environments, including such things as amino acids, chlorophyll degradation productions, and plant pigments. (See also W90-04308)(Lantz-PTT)
W90-04321

CALIFORNIA'S EXPERIENCE WITH MOSQUITOES IN AQUATIC WASTEWATER TREATMENT SYSTEMS.
California State Water Resources Control Board, Sacramento.
For primary bibliographic entry see Field 5D.
W90-04425

SCIENCE, LAW, AND HUDSON RIVER POWER PLANTS: A CASE STUDY IN ENVIRONMENTAL IMPACT ASSESSMENT.
American Fisheries Society, Bethesda, Maryland, 1988. 4. Edited by Lawrence W. Barnthouse, Ronald J. Klauda, Douglas S. Vaughan and Robert L. Kendall. 347p.

Descriptors: *Nuclear powerplants, *Fisheries, *Hudson River, *Entrainment, *Thermal powerplants, *Environmental effects, Hydroelectric plants, Impingement, Environmental policy, Baseline studies, Decision making.

Between 1963 and 1980, the Hudson River estuary was the focus of one of the most ambitious environmental research and assessment programs ever performed. The studies supported a series of U.S. federal proceedings involving licenses and discharge permits for two controversial electric power generating facilities: the Cornwall pumped storage facility, and units 2 and 3 of the Indian Point nuclear generating station. Both facilities were to draw large volumes of water from a region of the Hudson used as spawning and nursery habitat by several fish species, including the striped bass. Fishermen and conservationists feared that a major fraction of the striped bass eggs and larvae in the Hudson would be entrained with the pumped water and killed. Additional fish would be killed (and had been killed at Indian Point unit 1) when they were impinged (trapped) on trash screens at the intakes. Scientists were asked to aid the utility companies and regulatory agencies in determining the biological importance of entrainment and impingement. This monograph contains both technical papers that present research results and synthesis papers that summarize and interpret the results. The intent was to: (1) summarize the scientific issues and approaches; (2) present the significant results of the Hudson River biological studies; (3) describe the role of the studies in the decision-making process; (4) evaluate the successes and failures of the studies; and (5) present recommendations for future estuarine impact assessments. (See W90-04506 thru W90-04529) (WhiteReimer-PTT)
W90-04505

TECHNICAL DESCRIPTIONS OF HUDSON RIVER ELECTRICITY GENERATING STATIONS.
Orange and Rockland Utilities, Inc., Pearl River, NY.
For primary bibliographic entry see Field 6D.
W90-04511

ADVANCES IN FIELD AND ANALYTICAL METHODS FOR ESTIMATING ENTRAINMENT MORTALITY FACTORS.
EA Engineering, Science, and Technology, Inc., Middletown, NY.
For primary bibliographic entry see Field 8I.
W90-04512

HISTORICAL DEVELOPMENT OF ENTRAINMENT MODELS FOR HUDSON RIVER STRIPED BASS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 8I.
W90-04513

HISTORICAL REVIEW OF ENTRAINMENT IMPACT ESTIMATES AND THE FACTORS INFLUENCING THEM.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 8I.
W90-04514

ANALYSIS OF IMPINGEMENT IMPACTS ON HUDSON RIVER FISH POPULATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. W. Barnthouse, and W. Van Winkle.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 182-190. 1 fig, 3 tab, 23 ref, append. IAG DOE 40-740-78, IAG DOE 40-550-75, Contract DE-AC05-84OR21400.

Descriptors: *Environmental effects, *Powerplant effects, *Entrainment, *Thermal powerplants, *Nuclear powerplants, *Estuarine fisheries, *Hudson River Estuary, *Impingement, Life history studies, White perch, Striped bass, Atlantic tomcod, Shad, Alewife, Blueback herring.

Impacts of impingement, expressed as reductions in year-class abundance, were calculated for six Hudson River fish populations. Estimates were made for the 1974 and 1975 year classes of white perch, striped bass, Atlantic tomcod, and American shad, and the 1974 year classes of alewife and blueback herring. The maximum estimated reductions in year-class abundance were less than 5% for all year classes except the 1974 and 1975 white perch year classes and the 1974 striped bass year class. Only for white perch were the estimates greater than 10% per year. For striped bass, the 146,000 fish from the 1974 year class that were killed by impingement could have produced 12,000-16,000 5-year-old fish or 270-300 10-year-olds. Also estimated were the reductions in mortality that could have been achieved had closed-cycle cooling systems been installed at one or more of three power plants (Bowline Point, Indian Point, and Roseton) and had the screen-wash systems at Bowline Point and Indian Point been modified to improve the survival of impinged fish. Closed-cycle cooling at all three plants would have reduced impingement impacts on white perch, striped bass, and Atlantic tomcod by 75% or more; installation of closed-cycle cooling at Indian Point alone would have reduced impingement impacts on white perch and Atlantic tomcod by 50%-80%. Modified traveling screens would have been less effective than closed-cycle cooling, but still would have reduced impingement impacts on white perch by roughly 20%. (See also W90-04505) (Author's abstract)
W90-04518

DEVELOPMENT AND SENSITIVITY ANALYSIS OF IMPACT ASSESSMENT EQUATIONS BASED ON STOCK-RECRUITMENT THEORY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
I. R. Savidge, J. B. Gladden, K. P. Campbell, and J. S. Ziesenis.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 191-203. 4 fig, 2 tab, 33 ref. DOE DE-AC09-765R00-819.

Descriptors: *Environmental effects, *Estuarine fisheries, *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Entrainment, *Impingement, Mathematical models, Hudson River Estuary, Population studies, Life cycles, Mortality.

A central and unresolved problem in assessing the impact of power plant operations on Hudson River fish populations was the prediction of long-term population changes resulting from impingement and entrainment mortality. A series of equations was developed from the Ricker and Beverton-Holt stock-recruitment models to address this issue. It was assumed that compensation occurs during a brief period early in the life cycle rather than

throughout the life cycle. Equations were developed for the added power plant-induced mortality occurring before or after compensation in each model. Mortality added after compensation resulted in larger estimates of population reduction than mortality added before compensation. The simple deterministic and more complex age-structured models provided identical predictions of long-term changes in population size in most cases. Similarly, the simple models predicted population changes that were nearly identical to the average age-structured model with variable survival except when levels of variation were quite high and the population modeled was semelparous (reproducing at a single age). Advantages of the equations developed herein are their simplicity, generality, and minimal data requirements. The simple models, as formulated, cannot incorporate multiple sources of mortality or multiple sources of density dependence in differing life stages, particularly when the rates or functional relationships of these processes are likely to vary from year to year. The predictions of long-term population changes resulting from impingement and entrainment mortality were not attained. The magnitude and form of the compensatory responses of Hudson River fish populations remained undetermined, so that an agreement on this critical component of prediction models could not be reached. (See also W90-04505) (Author's abstract)
W90-04519

FISHING IN DANGEROUS WATERS: REMARKS ON A CONTROVERSIAL APPEAL TO SPAWNER-RECRUIT THEORY FOR LONG-TERM IMPACT ASSESSMENT.
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
For primary bibliographic entry see Field 8I.
W90-04522

IMPLICATIONS OF POWER PLANT MORTALITY FOR MANAGEMENT OF THE HUDSON RIVER STRIPED BASS FISHERY.
Fish and Wildlife Service, Ann Arbor, MI.
For primary bibliographic entry see Field 8I.
W90-04523

HUDSON RIVER COOLING TOWER PROCEEDING: INTERFACE BETWEEN SCIENCE AND LAW.
LeBoeuf, Lamb, Leiby and MacRae, New York.
For primary bibliographic entry see Field 6E.
W90-04527

WHAT WE DIDN'T LEARN ABOUT THE HUDSON RIVER, WHY, AND WHAT IT MEANS FOR ENVIRONMENTAL ASSESSMENT.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 6B.
W90-04529

7. RESOURCES DATA

7A. Network Design

WATER-USE DATA COLLECTION PROGRAM IN MISSISSIPPI.
Geological Survey, Jackson, MS. Mississippi District.
For primary bibliographic entry see Field 6D.
W90-03718

REVIEW OF PRESENT RISK ASSESSMENT MODELS FOR PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Div. of Nursing.
For primary bibliographic entry see Field 5C.
W90-03847

EXPERIENCES OF QUALITY CONTROL OF RAW WATER STORAGE RESERVOIRS.
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W90-03968

LAND-USE AND WATER QUALITY RELATIONSHIPS IN THE GEORGES CREEK BASIN, MARYLAND.
Frostburg State Coll., MD. Dept. of Geography.
For primary bibliographic entry see Field 4C.
W90-04177

EVALUATION OF SOME APPROACHES TO ESTIMATING NON-POINT POLLUTANT LOADS FOR UNMONITORED AREAS.
Heidelberg Coll., Tiffin, OH. Water Quality Lab.
For primary bibliographic entry see Field 5A.
W90-04187

ESTIMATING MEAN AND VARIANCE FOR ENVIRONMENTAL SAMPLES WITH BELOW DETECTION LIMIT OBSERVATIONS.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 7C.
W90-04188

EPISODIC RESPONSE PROJECT RESEARCH PLAN.
FTN Associates, Little Rock, AR.
For primary bibliographic entry see Field 5C.
W90-04214

STATE MONITORING PROGRAMS.
For primary bibliographic entry see Field 5G.
W90-04226

ANALYTICAL METHODS AND TOOLS FOR RECONNAISSANCE-PHASE STUDIES.
Hydrologic Engineering Center, Davis, CA. Planning Div.
For primary bibliographic entry see Field 7B.
W90-04241

MANAGEMENT OF RECONNAISSANCE PHASE STUDIES.
Corps of Engineers, Baltimore, MD. Baltimore District.
J. F. Johnson.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 129-139, 1 fig, 1 tab.

Descriptors: *Nonstructural alternatives, *Reconnaissance studies, *Flood plain management, *Cost sharing, Cost-benefit analysis, Feasibility studies, Economic aspects.

The problems of managing a program that includes several reconnaissance phase studies, and the lessons learned from this experience are addressed. Eight reconnaissance studies were initiated under the two-phase planning approach since 1984, seven of which have been completed. These have led to six cost shared feasibility studies, one of which is sponsored by two states. In addition, another 'appraisal' study is scheduled to be initiated this fiscal year, and another reconnaissance study in FY1989. All of these reconnaissance studies reflect high Administration priorities; they either have had, or expect they will lead to, cost-shared feasibility studies; and they should result in economically feasible projects. Based on the experience with a full range of cost sharing partners, and economic, geographic, institutional, and other conditions, the systems of cost shared, two-phased planning is working. (See also W90-04234) (Lantz-PTT)
W90-04245

RECONNAISSANCE PHASE STUDIES--A DIVISION PERSPECTIVE.
Corps of Engineers Lower Mississippi Valley Div., New Orleans, LA. Planning Div.
D. E. G. Lawhun.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 141-151.

Descriptors: *Nonstructural alternatives, *Reconnaissance studies, *Flood plain management, Water resources management, Economic aspects.

The reconnaissance study program is the current foundation for the entire future Civil Works program of the Corps of Engineers. The Corps must maintain a healthy reconnaissance program if it is to remain as a viable organization. The reconnaissance study is the first step in meeting water resources needs for the future. The Corps must be immediately responsive to requests to initiate reconnaissance studies, and be very careful in applying policies which will not allow the Corps to be responsive. A separate funding target should be provided for reconnaissance studies so that they are not required to compete for funds with projects in the early stages, which are now all a part of the combined General Investigations budget. Particular concern needs to be given to the approval or certification process when reconnaissance studies are completed so that the Corps can move quickly and efficiently into the feasibility phase for those projects which meet policy and legislative requirements, and are responsive to the needs of the people of the United States. (See also W90-04234) (Lantz-PTT)
W90-04246

STATISTICAL ANALYSIS OF GROUNDWATER MONITORING DATA AT RCRA FACILITIES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-151047. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/530-SW-89-026, February 1989. 138p, 11 fig, 16 tab, 54 ref, 3 append.

Descriptors: *Water pollution control, *Water quality control, *Groundwater quality, *Statistical methods, *Monitoring, *Standards, Resource Conservation and Recovery Act, Case studies, Groundwater pollution.

The hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) require owners and operators of hazardous waste facilities to utilize design features and control measures that prevent the release of hazardous waste into groundwater. This document provides guidance to RCRA facility permit applicants and writers concerning the statistical analysis of groundwater monitoring data at RCRA facilities. Section 1 is an introduction to the guidance; it describes the purpose and intent of the document, and emphasizes the need for site-specific considerations in implementing the Subpart F regulations of 40 CFT Part 264. Section 2 provides the reader with an overview of the recently promulgated regulations concerning the statistical analysis of groundwater monitoring data. Section 3 discusses the important geohydrologic parameters to consider when choosing a sampling interval. Section 4 provides guidance on choosing an appropriate statistical method. Section 5 covers statistical methods that may be used to evaluate groundwater monitoring data when background wells have been sited hydraulically upgradient from the regulated unit, and a second set of wells are sited hydraulically downgradient from the regulated unit at the point of compliance. Section 6 includes statistical procedures that are appropriate when comparing groundwater constituent concentrations to fixed concentration limits (e.g., alternate concentration limits or maximum concentration limits). The methods applicable to this type of comparison are confidence intervals and tolerance intervals. Section 7 presents the case where the level of each constituent within a single, uncontaminated well is being compared to its historic background concentrations. Section 8 contains a variety of special topics that are relatively short and self contained. These topics include methods to deal with data that is below the limit of analytical detection and methods to test for outliers or extreme values in the data. Finally, the guidance presents appendices

that cover general statistical considerations, a glossary of statistical terms, statistical tables, and a listing of references. (Lantz-PTT)
W90-04250

SIMPLE SYSTEM TO MANAGE A HYDROLOGICAL DATA BASE - APPLICATION OF PERSONAL COMPUTERS/UN SYSTEME SIMPLE DE GESTION D'UNE BASE DE DONNEES HYDROLOGIQUES - APPLICATION POUR ORDINATEURS PERSONNELS).
Institut Royal Meteorologique de Belgique, Brussels. Hydrology Section.
For primary bibliographic entry see Field 7C.
W90-04293

RELIABILITY OF IMPINGEMENT SAMPLING DESIGNS: AN EXAMPLE FROM THE INDIAN POINT STATION.
Normandeau Associates, Inc., Bedford, NH.
For primary bibliographic entry see Field 8I.
W90-04516

7B. Data Acquisition

MICROTOX ASSESSMENT OF ANAEROBIC BACTERIAL TOXICITY.
Massachusetts Univ., Amherst. Environmental Engineering Program.
For primary bibliographic entry see Field 5D.
W90-03596

GEOMORPHIC MEASUREMENTS AFTER A FLOOD.
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 2E.
W90-03665

WATER-USE DATA COLLECTION PROGRAM IN MISSISSIPPI.
Geological Survey, Jackson, MS. Mississippi District.
For primary bibliographic entry see Field 6D.
W90-03718

ISCO OPEN CHANNEL FLOW MEASUREMENT HANDBOOK.
Isco, Inc., Lincoln, NE. Environmental Div.
D. M. Grant.
Isco, Inc., Lincoln, Nebraska. 1978, 356 p.

Descriptors: *Gaging, *Stream gages, *Instrumentation, *Measuring instruments, *Handbooks, *Open-channel flow, *Flow measurement, Fluid mechanics, Hydraulics, Channel flow, Weirs, Flumes, Gravity flow.

This handbook provides assistance to individuals involved in measuring open channel flow. The book is divided into seventeen chapters, the first of which provides a general introduction to the handbook and to the subject. The second chapter discusses open channel flow measurement in general terms. The third chapter describes in detail the use of weirs. The fourth chapter gives an in-depth look at flumes. The fifth chapter contains methods for selecting primary devices. The sixth chapter discusses the measurement of gravity flow using the Manning formula. The seventh chapter provides practical information on flow measurement system installations. Chapters eight through sixteen provide discharge tables on many commonly used primary measuring devices. The final chapter, seventeen, present conversion tables used in flow measurement work. (Lantz-PTT)
W90-03749

HYDROLOGIC SYSTEMS. VOLUME I: RAINFALL-RUNOFF MODELING.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03764

AUTOMATIC RAINFALL LOGGER AND SAMPLER FOR FIELD USE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
J. W. Smith, J. V. Turner, and C. J. Harris.
CSIRO Technical Memorandum 89/7, June 1989. 20p, 6 fig, 1 tab, append.

Descriptors: *Rain gages, *Instrumentation, *Logging (Recording), *Measuring instruments, *Rainfall, *Field tests, Automation, Water sampling, Dry deposition, Monitoring.

A programmable rainfall fraction collector has been designed and assembled. Under field operation the unit controls the collection of multiple sequential samples of rainfall while also logging data on the timing and amount of rainfall. The control program may be readily modified in the field to suit changing rainfall sampling and monitoring requirements. The unit can be modified to suit applications such as studies of rain water chemistry and pollution or to assess wet and dry components of atmospheric chemical fallout. (Author's abstract)
W90-03798

DETECTION OF COARSE SEDIMENT MOVEMENT USING RADIO TRANSMITTERS.
Army Cold Regions Research and Engineering Lab., Fort Wainwright, AK. Alaskan Projects Office.
E. F. Chacho, R. L. Burrows, and W. W. Emmett.
IN: International Association for Hydraulic Research XXIII Congress, August 21-25, 1989, Ottawa, Canada. 1989. p B367-B373, 3 fig, 1 tab, 7 ref.

Descriptors: *Telemetry, *Remote sensing, *Sediment transport, Particle size, Flow profiles, Turbidity.

The use of radio transmitters to track and locate coarse sediment (39 mm or larger) was successfully demonstrated by tracking five individual rocks through a highly mobile, braided river system. Radio-implanted rocks traveling distances > 1,500 m in 8 days were tracked during periods of high flow and turbid water conditions. After flow receded and access to the bars and channels was possible, the rocks were again located and recovered even though burial of up to 0.3 m had occurred. A motion sensing device which detects whether a particle is in motion or at rest was also tested successfully. (Author's abstract)
W90-03821

CORRELATION OF SCANNING MULTICHANNEL MICROWAVE RADIOMETER (SMMR) OBSERVATIONS WITH SNOWPACK PROPERTIES OF THE UPPER COLORADO RIVER BASIN FOR WATER YEAR 1986.
Geological Survey, Tacoma, WA.
E. G. Josberger, C. H. Ling, W. J. Campbell, P. Gloersen, and A. T. C. Chang.
IN: Remote Sensing: An Economic Tool for the Nineties. 12th Canadian Symposium on Remote Sensing, (1989). p1239-1242, 4 fig, 1 tab, 4 ref.

Descriptors: *Snowpack, *Microwaves, *Remote sensing, *Colorado River Basin, Colorado, Utah, Wyoming, Satellite technology, Radiometry, Scanning multichannel microwave radiometer.

For the Upper Colorado River Basin, the grided 18 and 37 gigaHertz brightness temperatures from the Scanning Multichannel Microwave Radiometer (SMMR) on the Nimbus-7 satellite and snowpack properties measured by the automatic, remote snow observation sites of the Soil Conservation Service (SNOTEL) provide unique time series data sets for passive microwave snow studies. Time series of the correlation coefficients using the SNOTEL data and a combination of the brightness temperatures from the 1/4 degree latitude by 1/4 degree longitude pixels that contain one or more of the 100 SNOTELs show that the correlations are generally greater than 0.8 and can attain values as great as 0.95. The correlations remain high until a basin-wide warming event occurs which produces liquid water in the snowpack that abruptly lowers the correlation. The envelopes of the correlations for the Utah and Wyoming snowpacks are significantly different than that for the Colorado pack. (Author's abstract)
W90-03823

HYDROLOGIC INFORMATION AND ANALYSES REQUIRED FOR MITIGATING HYDROLOGIC EFFECTS OF URBANIZATION.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W90-03896

USE OF A NOVEL ACETONE-H2O2-CLO(-) CHEMILUMINESCENCE SYSTEM FOR THE DETERMINATION OF IODIDE ION.
University of Science and Technology of China, Hefei. Dept. of Applied Chemistry.
X. Lu, M. Lu, and F. Yin.
Analytical Letters ANALBP, Vol. 22, No. 9, p 2051-2058, August 1989. 3 fig, 2 tab, 5 ref.

Descriptors: *Water analysis, *Iodides, *Water chemistry, *Chemical analysis, *Laboratory methods, Chemiluminescence, Acetone, Hydrogen peroxide, Hypochlorite ions.

A new chemiluminescence system, which can be catalyzed by iodide ion (I(-)), is reported. Based on this catalysis, a new chemiluminescence (CL) method for the determination of trace iodide ion is proposed. The reagent concentrations giving the highest CL signal were found to be 49.7% (by weight) acetone, 1.45 M hydrogen peroxide, and 0.02 M hypochlorite. The CL intensity is at a maximum and constant when the pH of the hypochlorite solution is at least 13.2. Although some foreign ions, such as Co(++), Ni(++), and Cu(++), interfered with the determination of I(-) when present at over 10 times the iodide 10n concentration, their interference can be obviated by use of 0.005 M EDTA as a masking reagent. The detection limit is 20 picograms/ml i(-), the linear dynamic range is 40 nanograms/ml to 30 micrograms/ml I(-), and the coefficient of variation at an iodide concentration of 5 nanograms/ml I(-) (n = 10) is 4.6%. The method has been satisfactorily applied to the determination of trace iodide ion in water. (Shidler-PTT)
W90-03920

REMOTE SENSING AND FULLY DISTRIBUTED MODELING FOR FLOOD FORECASTING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03980

NEW EXPRESSION FOR THE UNCERTAINTY OF A CURRENT METER DISCHARGE MEASUREMENT.
Danish Land Development Service, Slagelse.
M. Lintrup.
Nordic Hydrology NOHYBB, Vol. 20, No. 3, p 191-200, 1989. 2 tab, 10 ref.

Descriptors: *Errors, *Denmark, *Norway, *Flex Method, *Discharge measurement, *Current meters, Stream profiles, Hydraulic geometry, Performance evaluation, Standards.

A method for the conduct of routine current meter discharge measurements as practiced in Denmark and Norway (the 'Flex method') consists of two uncertainty equations, termed 'coarse' and 'fine.' The first of these equations accounts for overall measurement characteristics; the second equation accounts for individual vertical characteristics. Contrary to traditional methods (International Standard Organization recommendations), the Flex method incorporates information about the geometry of the stream profile in question into the choice of measurement layout. An associated method for calculation of the measurement uncertainty has been developed. By tentative application to a test set of measurements, it is rendered probable that

the developed method will be able to provide satisfactory estimates of the uncertainty of current meter measurements while having a wider applicability and being easier to use than existing methods. (Rochester-PTT)
W90-03987

UNRELIABILITY OF COLD-STORED SAMPLES FOR ASSESSMENT OF CHEMICAL PRECIPITATES OF PHOSPHATE IN ACTIVATED SLUDGE.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-03995

USE OF THE ANALYTICAL PROFILE INDEX IN THE IDENTIFICATION OF ACTIVATED SLUDGE BACTERIA: PROBLEMS AND SOLUTIONS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-03997

COMPARATIVE EXAMINATIONS OF THE ADSORPTIVE ELIMINATION AND IDENTIFICATION OF ORGANIC SUBSTANCES IN THE WATER USING DIFFERENT FILTERING MEDIA: PART 2 (VERGLEICHENDE UNTERSUCHUNGEN ZUR ADSORPTIVEN ELIMINIERUNG UND IDENTIFIZIERUNG VON ORGANISCHEN WASSERINHALTSSTOFFEN AN UNTERSCHIEDLICHEN FILTER-MEDIEN). (2. MITT).
H. Thielemann.
Zeitschrift fuer Wasser - und Abwasser Forschung ZWABAQ, Vol. 22, No. 5, p 185-187, October 1989. 1 fig, 2 tab, 5 ref. English summary.

Descriptors: *Water analysis, *Organoleptic properties, *Germany, *Organic matter, *Filtration, *Water treatment, *Drinking water, Phenols, Taste, Odors, Comparison studies, Performance evaluation, Adsorption.

Organic substances in water were eliminated and identified with the aid of different adsorptive methods at the in Halle district waterworks in East Germany. A comparison made of the performance of activated carbon WDW 24 and vinyl acetate Silan resin within the framework of these studies showed the synthetic adsorber to be superior. Because water-vapor-volatile phenol compounds occupy a special position as agents responsible for producing the smell and taste of drinking water as a result of chlorination, special importance was attached to the detection of phenol compounds. (Author's abstract)
W90-03998

MODERN METHODS IN WATER ANALYSIS.
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
For primary bibliographic entry see Field 5A.
W90-04016

EFFICACY OF PHOSPHOLIPID ANALYSIS IN DETERMINING MICROBIAL BIOMASS IN SEDIMENTS.
Maine Univ., Walpole. Ira C. Darling Center for Research, Teaching and Service.
R. H. Findlay, G. M. King, and L. Watling.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 11, p 2888-2893, November 1989. 1 fig, 6 tab, 44 ref. NSF Grant OCE 8700358.

Descriptors: *Water analysis, *Chemical analysis, *Bacterial analysis, *Phosphates, *Biomass, *Sediments, *Lipids, Benthos, Detritus, Separation techniques, Mud flats, Dyes, Aquatic bacteria.

Improvements in the analysis of lipid-bound phosphates resulted in a simplified and sensitive method for determining microbial biomass in sediments. Sensitivity was enhanced over previous methods by use of a dye, malachite green, which when complexed with phosphomolybdate at low pH has a high extinction coefficient (at 610 nm). The use of a persulfate oxidation technique to liberate phosphate from lipids increased the simplicity and safety of the method relative to the traditional perchloric acid digestions. The modified method was both accurate (yielding quantitative recoveries of cells added to sediments) and precise (coefficient of variation of less than 5% for cells and sediments). A comparison with an epifluorescence technique indicated that the analysis of lipid-bound phosphate was more rapid and less tedious and could be successfully applied to a wider variety of sediment types. An estimate of the lipid-bound phosphate-to-carbon conversion factor based on a diverse enrichment culture from sediments suggested that previous factors for pure cultures may have been too low. (Author's abstract)
W90-04034

FIBER-OPTIC DIPPING SENSOR FOR ORGANIC SOLVENTS IN WASTEWATER.
Erlangen-Nuernberg Univ., Erlangen (Germany, F.R.). Inst. fuer Physikalische und Theoretische Chemie.
F. L. Dickert, S. K. Schreiner, G. R. Mages, and H. Kimmel.
Analytical Chemistry ANCHAM, Vol. 61, No. 20, p 2306-2309, October 1989. 7 fig, 10 ref.

Descriptors: *Water analysis, *Organic solvents, *Ammonia, *Optical properties, *Wastewater analysis, *Dyes, *Fiber optics, *Pollutant identification, Industrial wastewater.

Large amounts of wastewater are produced in the chemical industry that need to be continuously analyzed according to their organic constituents. A fiber optic system was developed which uses triphenylmethane dyes as sensor materials for the detection of organic solvents and gases (ammonia) in water via changes in optical absorbance. For this purpose these sensor layers were separated from the aqueous solutions by a gas-permeable membrane. The measurements were performed with a quartz fiber arrangement using optical detection in the visible range. The distinct vapor pressures of the organic solvents in water lead to an enhancement of the sensor selectivity in comparison to the analogous gas-phase studies. Down to approximately 30 ppm organic solvents in water can be analyzed in favorable cases. (Geiger-PTT)
W90-04036

HOLLOW FIBER MEMBRANE PROBES FOR THE IN SITU MASS SPECTROMETRIC MONITORING OF NITROGEN TRICHLORIDE FORMATION DURING WASTEWATER TREATMENT.
Dow Chemical Co., Midland, MI. Analytical Sciences.
For primary bibliographic entry see Field 5D.
W90-04038

DETERMINATION OF FLUORIDE IN NATURAL WATERS BY ION-SELECTIVE ELECTRODE POTENTIOMETRY AFTER CO-PRECIPITATION WITH ALUMINIUM PHOSPHATE.
Nihon Univ., Tokyo. Dept. of Industrial Chemistry.
T. Okutani, C. Tanaka, and Y. Yamaguchi.
Talanta TLNTA2, Vol. 36, No. 10, p 973-976, October 1989. 2 fig, 4 tab, 17 ref.

Descriptors: *Water analysis, *Chemical analysis, *Pollutant identification, *Fluorides, *Natural waters, *Aluminum, Potentiometry, Electrodes, Trace elements, Separation techniques, Hydrogen ion concentration.

The most effective conditions for masking aluminum in the determination of microgram/liter levels of fluoride in water by ion-selective electrode potentiometry after co-precipitation with aluminum phosphate have been re-examined. The effectiveness of citrate for masking aluminum increases with pH, and up to .015 M aluminum can be masked quantitatively at pH 8.5. Fluoride (5-100 micrograms in 500 ml of sample solution) is quantitatively co-precipitated at pH 4.7 with approximately 90 ml of aluminum phosphate. After dissolution of the precipitate and adjustment of the solution to pH 8.5 with total ionic strength adjustment buffer, the fluoride content can be measured with a fluoride ion selective electrode. The method is simple and rapid, and is suitable for the determination of trace amounts of fluoride in various water samples. (Author's abstract)
W90-04066

CONCENTRATION OF GIARDIA LAMBLIA CYSTS, LEGIONELLA PNEUMOPHILA, CLOSTRIDIUM PERFRINGENS, HUMAN ENTERIC VIRUSES, AND COLIPHAGES FROM LARGE VOLUMES OF DRINKING WATER, USING A SINGLE FILTRATION.
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
For primary bibliographic entry see Field 5F.
W90-04095

PREDICTION OF SEDIMENT SAMPLING ERROR AT NOZZLE.
Hydraulics Research Ltd., Wallingford (England).
E. Atkinson.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1696-1701, December 1989. 4 fig, 5 ref.

Descriptors: *Samplers, *Error analysis, *Mathematical equations, *Sediment sampler, *Suspended sediments, *Sand, Nozzles, Flow velocity.

The pump-sampling technique for the measurement of suspended sand concentrations has become more widespread in recent years. An important source of error in pump sampling is the effect of a mismatch between the stream velocity at a sampling nozzle and the velocity of the flow through the nozzle. This error may be above 50%, but more typical values are 10-20%. This note presents a predictive equation which can be used to produce correction factors for the error. It is also shown that errors due to misalignment of nozzles are likely to be very small. (Sand-PTT)
W90-04126

PHYSICAL HYDRAULIC MODELLING OF WIDTH REDUCTION AND BED LEVEL CHANGE IN BRAIDED RIVERS.
Lincoln Coll., Canterbury (New Zealand). Dept. of Natural Resource Engineering.
For primary bibliographic entry see Field 2J.
W90-04132

SOME RECENT DEVELOPMENTS OF CONSTANT-INJECTION SALT DILUTION GAUGING IN RIVERS.
Department of Scientific and Industrial Research, Christchurch (New Zealand). Water Resources Survey.
D. E. Johnstone.
Journal of Hydrology (New Zealand) JLHYAD, Vol. 27, No. 2, p 128-153, 1988. 14 fig, 2 tab, 16 ref.

Descriptors: *River flow, *Streamflow, *Flow measurement, *Gaging, *Stream gages, *Tracers, *Turbulent flow.

Improved equipment and techniques have increased the scope and accuracy of constant-injection salt dilution gauging. A Water Resources Survey method has been used to measure flows up to 100 cu m/s, with uncertainty < or = 5%. For large flows accuracy is optimized by using the maximum possible tracer injection rate and concentration. Constant-injection salt gagings can be automated with potential to greatly expedite collection of flood flow date. Where a series of salt gagings is to be carried out and it is convenient to prepare a large stock of tracer solution, a precalibration method can be used which significantly reduces the time required for determination of the individual gaugings. Natural or induced conductivity differences in tributaries can be used to estimate the ratio of the tributary flows, allowing the three

flows at a confluence to be calculated from one flow gaging. (Author's abstract)
W90-04133

CORRECTNESS TEST OF THE COMPUTATION OF CHEMICAL SPECIATION FOR THE MAIN CONSTITUENTS OF NATURAL WATERS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Radiochemie.
For primary bibliographic entry see Field 2K.
W90-04144

ACCURATE ESTIMATION OF CONDUCTIVITY OF WATER FROM GEOELECTRIC MEASUREMENT–A NEW WAY TO CORRECT FOR CLAY.
California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
For primary bibliographic entry see Field 2F.
W90-04157

WQSTAT II: A WATER QUALITY STATISTICS PACKAGE.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 7C.
W90-04165

SPECTRAL SIGNATURE OF ALPINE SNOW COVER FROM THE LANDSAT THEMATIC MAPPER.
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 2C.
W90-04189

COMPARISON OF IN SITU AND LANDSAT DERIVED REFLECTANCE OF ALASKAN GLACIERS.
National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.
For primary bibliographic entry see Field 2C.
W90-04190

REMOTE SENSING AND NUMERICAL MODELING OF SUSPENDED SEDIMENT IN LAGUNA DE TERMINOS, CAMPECHE, MEXICO.
South Carolina Univ., Columbia. Dept. of Geography.
J. R. Jensen, B. Kjerfve, E. W. Ramsey, K. E. Magill, and C. Medeiros.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 33-44, April/June 1989. 4 fig, 5 tab, 37 ref. NASA Grant NAS5-28741.

Descriptors: *Model studies, *Satellite technology, *Remote sensing, *Suspended solids, Data acquisition, Estuaries, Model studies, Thematic Mapper, Comparison studies.

The spatial distribution of total suspended solids in a tropical coastal lagoon was modeled using a coupled hydrodynamic dispersion model and transformed Thematic Mapper data. Total suspended solids (TSS) and salinity concentrations measured at 22 field sites during different field expeditions were used to calibrate the model. The model was then used to simulate the TSS distribution at the time of the April 24, 1987, TM overpass. Subsequently, statistical comparisons between the model simulated TSS data and TM data, chromaticity data, and principal component transformations at each of the 22 field sampling locations were made. An atmospherically corrected chromaticity transformation of the TM data that assumed a heterogeneous haze component accounted for 79% of the modeled TSS variance. An innovative method that generated a covariance image was then used to compare the spatial distribution of the modeled and remote sensing derived TSS estimates. In coastal lagoon/estuarine systems where longterm hydrographic data are meager or unavailable, these techniques may be a feasible alternative for estimating and predicting circulation and dispersion characteristics. (Author' abstract)
W90-04191

ANALYSIS OF THEMATIC MAPPER DATA FOR STUDYING THE SUSPENDED MATTER DISTRIBUTION IN THE COASTAL AREA OF THE GERMAN BIGHT (NORTH SEA).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 2J.
W90-04193

DETECTING BIOTIC AND HYDROGEOCHEMICAL PROCESSES IN LARGE PEAT BASINS WITH LANDSAT TM IMAGERY.
Minnesota Univ., Minneapolis. Limnological Research Center.
P. H. Glaser.
Remote Sensing of the Environment RSEEA7, Vol. 28, p 109-119, April/June 1989. 3 fig, 1 tab, 28 ref. NASA Grant NAS5-28740.

Descriptors: *Remote sensing, *Satellite technology, *Mapping, *Peat bogs, *Surface-groundwater relations, *Landsat Thematic Mapper, Alkalinity, Vegetation, Distribution, Flow pattern.

A survey was made of three large peat basins in boreal North America with Landsat TM imagery and field sampling. Landsat TM imagery indicates that the discharge of alkaline groundwater is largely responsible for the development of vegetation patterns in the large peat basins of North America. Although the vegetation landforms within these major peat basins are visible on aerial photographs, Landsat TM imagery provides essential new evidence for their analysis. Spectral data from the Landsat TM system provides: (1) synoptic views of the patterns across large portions of these peat basins, indicating important physiographic controls on peatland development; (2) more sensitive detection of the major vegetation types, allowing rapid quantitative estimates to be make of their distribution and aerial extent; (3) discrimination of bog areas with potential rapid or slow rates of peat accumulation; (4) identification of discharge zones for groundwater, which apparently represents the most important source of alkalinity in these peat basins; and (5) detection of flow patterns in water tracks that appear nearly uniform on standard aerial photographs. These large peat basins seem to be ideally suited for study by Landsat TM imagery because of: (1) the large relatively uniform stands of vegetation; and (2) the intimate feedback systems that have developed between the vegetation and hydrogeochemical processes. (Author's abstract)
W90-04195

PROCEEDINGS OF A SEMINAR ON FLOOD DAMAGE REDUCTION RECONNAISSANCE-PHASE STUDIES.
For primary bibliographic entry see Field 6F.
W90-04234

OVERVIEW OF THE RECONNAISSANCE-FEASIBILITY STUDY AND PLANNING PROCESS-PROGRAM.
Corps of Engineers, Washington, DC.
For primary bibliographic entry see Field 6A.
W90-04235

RECONNAISSANCE STUDIES A HYDROLOGIC ENGINEER'S PERSPECTIVE.
Army Engineer District, Omaha, NE.
E. W. Sizemore.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 27-38, 3 tab.

Descriptors: *Nonstructural alternatives, *Reconnaissance studies, *Hydrologic aspects, *Water resources management, Feasibility studies, Management planning.

The two primary purposes of a reconnaissance phase study are to determine if there is federal interest and, if so, the scope and cost of the feasibility phase studies. The time and funds available to conduct reconnaissance phase studies are limited. Policy concerning the scope, reliability, confidence, and management of the technical analysis, which serves as the foundation for scoping and estimating the cost of the feasibility report, should be clearly established. The management of studies using a 'study team' concept has been promoted within the U.S. Army Corps of Engineers for several years. Experience shows the success of this concept depends greatly on the personality of the study manager. This year the Corps is implementing the 'project management' concept for Civil Works studies utilizing independent lift cycle and team project managers. Thought must be given to how this new concept will change the way the Corps does business. Other areas of interest in the management of reconnaissance studies concern the functional responsibilities and interaction between organizational elements. They are apparently not consistent between Districts or even within a District. Experiences and opinions concerning the involvement of hydrologic engineering staffs in reconnaissance studies are discussed in this paper including forces at play today which require an even greater involvement of the hydrologic engineers earlier in the reconnaissance phase. Recent experience in seven reconnaissance studies in the Omaha District is discussed as well as the results of a survey of hydrologic engineers throughout the Corps. (See also W90-04234) (Lantz-PTT)
W90-04237

ANALYTICAL METHODS AND TOOLS FOR RECONNAISSANCE-PHASE STUDIES.
Hydrologic Engineering Center, Davis, CA. Planning Div.
D. W. Davis, and M. W. Burnham.
IN: Proceedings of a Seminar on Flood Damage Reduction Reconnaissance-Phase Studies. August 9-11, 1988, Hydrologic Engineering Center, Davis, CA. p 79-93, 2 tab, 11 ref.

Descriptors: *Nonstructural alternatives, *Reconnaissance studies, *Flood plain management, *Analytical methods, Feasibility studies, Flood damage, Computer programs.

Reconnaissance phase feasibility studies are required to determine if a feasible solution to an identified problem exists and whether there is a federal interest. The study must also identify a local sponsor. The studies are abbreviated full-scoped planning investigations that address the relevant technical, financial, and institutional issues. A first-cut plan formulation and evaluation will be performed. Engineering and economic analysis provides the basis for preliminary plan development and cost-benefit analysis. The studies will normally be for existing conditions with and without proposed plans of improvement. This paper describes study strategies and methods and identifies and discusses the application of traditional analysis tools for hydrologic engineering and flood damage/benefit analysis to reconnaissance phase investigations. The authors encourage careful technical study management and present three interrelated activities for performing the technical analyses. The activities involve: (1) establishing a field presence in the study area, (2) the use of desktop analysis methods, and (3) the application of presently available analytical tools to perform the hydrologic engineering and flood damage analyses. The latter emphasizes selected Hydrologic Engineering Center (HEC) developed computer programs and associated analysis methods. Adaptation of existing traditional analysis methods is appropriate for reconnaissance phase studies. Increased emphasis should be placed on establishing a field presence and performing desk-top analysis. Use of a major computer programs with abbreviated data can make a meaningful contribution to the quality and reliability of these studies if Crops managers and reviewers create an appropriate climate for the working-level technical professional. (See also W90-04234) (Lantz-PTT)
W90-04241

RECONNAISSANCE STUDY FOR OVERLAND PARK.

Overland Park, KS.
For primary bibliographic entry see Field 6F.
W90-04244

MANAGEMENT OF RECONNAISSANCE PHASE STUDIES.
Corps of Engineers, Baltimore, MD. Baltimore District.
For primary bibliographic entry see Field 7A.
W90-04245

COMPLETE DOCUMENTATION OF THE SYSTEM/USER MANUAL FOR THE RISK ASSESSMENT MODELS FOR LAND APPLICATION OF MUNICIPAL SLUDGES (RAMMS VERSION 3.0): VOLUME I.
Science Applications, Inc., McLean, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-149306. Price codes: A06 in paper copy, A01 in microfiche. (1989). 101 p. EPA Contract 68-03-3453 and SAIC Project 1-813-03-295-15.

Descriptors: *Land disposal, *Municipal wastewater, *Model studies, *Computer programs, Computer models, Handbooks, Risk assessment.

The US EPA has developed a series of models for calculating the risks associated with the land application of municipal sludge. These models were used in the development of the Proposed Technical Sludge Regulation, and have been collected together in a single, user friendly computer program. This manual contains a basic description of the risk assessment models, explains how to use the computer program, and documents the code, input, and output data for the program. The manual is organized in six chapters. The first chapter is a brief description of the risk assessment models as they are implemented by the program. The second chapter explains system requirements and how to install the program on appropriate systems. The third chapter explains how the program is structured and outlines options that can be invoked at different stages of execution. The fourth chapter steps through typical execution of the program, showing input screens and output screen that are encountered. The fifth chapter is the listing of the program code, and the sixth chapter is a listing of data files used by the program. (Lantz-PTT)
W90-04248

COMPUTER METHODS AND WATER RESOURCES: FIRST INTERNATIONAL CONFERENCE, MOROCCO 1988.
For primary bibliographic entry see Field 8B.
W90-04274

MEASUREMENT AND ANALYSIS OF DYNAMIC PRESSURES ON HYDRAULIC MODELS.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 8B.
W90-04298

DETERMINATION OF DESIGN EVENTS FOR PRECIPITATION USING THE TIME-VARIABLE DATA RECORDING METHOD.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 2B.
W90-04299

GROUNDWATER DATA ACQUISITION AND PROCESSING AT TWO RECHARGE DAMS.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W90-04300

THERMAL STRESS NUMERICAL ANALYSIS OF A CONCRETE UNDERGROUND DISCHARGE CONTROL.
Istituto Sperimentale Modelli e Strutture S.p.A., Bergamo (Italy).
For primary bibliographic entry see Field 8F.
W90-04306

APPLICABILITY OF SPACE ACQUIRED DATA FOR WATER RESOURCES MANAGEMENT.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
V. V. Salomonson, V. R. Algazi, and D. R. Wiesnet.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 125-140, 1 fig, 2 tab, 34 ref.

Descriptors: *Water resources data, *Satellite technology, *Water resources management, Landsat, Remote sensing, Radiometry, Data acquisition, Irrigation, Water conservation, TIROS, Hydrologic budget.

Remote sensing observations from spacecraft such as the Landsat and NOAA series have been applied in several instances. These applications have shown in nearly every instance that the large area synoptic overview as provided by these Multispectral Scanner Subsystem (MSS) and Very High Resolution Radiometer (VHRR) is a valuable, ancillary source of information when used in combination with conventional data. In cases involving, for example, irrigated land surveys, land use and surface cover inventories on large watersheds in or near urban areas (greater than several square kilometers in size) surface water and snowcover inventories. The use of satellite data can resulting very significant time and cost savings in watershed planning and runoff estimation efforts. Several technological advances, such as those associated with TIROS-N and Landsat-D should improve the utility of satellite remote sensing data for water resources management. More effort needs to be devoted to increasing reliability and speed in data delivery to operational hydrologists, engineers and planners as well improving the packaging and formatting of the data in order to reach the point where these data are widely and routinely applied or accepted into standard water resources management procedures and efforts. (See also W90-04308)(Lantz-PTT)
W90-04317

AUGMENTATION OF HYDROLOGIC RECORDS USING TREE RINGS.
Arizona Univ., Tucson. Lab. of Tree-Ring Research.
C. W. Stockton, and W. R. Boggess.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 239-265, 14 fig, 2 tab, 48 ref.

Descriptors: *Hydrologic data, *Dendrochronology, *Paleohydrology, *Flood frequency, Statistical analysis, Trees, Flow profiles, Flood flow, History, Mathematical studies.

Recent work has shown that tree-ring data can be used to extend available hydrologic records backward in time, providing a longer record from which to more accurately estimate the three most common statistics used in hydrology: the mean, the variance, and the first order correlation. In addition, records reconstructed from tree-ring data series can provide information on: (1) longest periods of sustained high or low flows; (2) the representativeness of the historical record in comparison to the long-term record reconstructed from tree-ring data; and (3) the long-term persistence as expressed by the Hurst coefficient. Among the useful features of tree-ring series as repositories of hydrologic information are their great number; their longevity; the critical fact that the information they contain is annually cumulative; and the absolute dating control. Thus, tree-ring data can be an important source of added information to the hydrologist, provided that hydrologic inferences based on such data can be supported by acceptable statistical controls. (See also W90-04308)(Lantz-PTT)
W90-04323

WATER SUPPLY FORECASTING IN CALIFORNIA--1976-78.
California State Dept. of Water Resources, Sacramento. Snow Surveys Branch.
C. H. Howard.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 285-294, 6 tab.

Descriptors: *Streamflow forecasting, *Water supply, *California, *Forecasting, *Water resources management, *Drought, Snowmelt, Runoff, Seasonal variation, Precipitation, Hydrologic data collections, Rainfall-runoff relationships.

California is particularly rich in natural water resources. Its mountain streams are rarely dry in so-called 'normal' years, when these watersheds produce large amounts of surface water in response to precipitation during the fall, winter, and spring. To make the best possible use of this vast resource, accurate and timely predictions of the amount of runoff that may be available are vitally important for a variety of wide-ranging purposes--hydroelectric power generation, agriculture, flood control, domestic and industrial uses, recreation--among others, all ultimately affecting the life and well-being of every Californian. The 1976, 1977, and 1978 runoff seasons posed some very unusual and challenging problems in the preparation and use of operational water supply forecasts in California. The 1976 April-July and water year unimpaired runoff for Central Valley watersheds, a major source of supply for most of the State, totaled only 34% and 43% of average, respectively, near-record low values. 1977 was classified as the driest year in over 100 years of record in California, minimum two-year runoff. In contrast, the 1978 April-July and water year Central Valley runoff percentages were 149% and 154% of average, respectively, the second or third highest of record. A forecasting problem which arose during the 1976 season was the lack of comparative data from previous dry years. Consequently, there was little basis for verification of the record low forecasts, and there was considerable need for subjective analysis and forecast adjustment. As the 1976 water year drew to a close, alternative strategies were being developed for water conservation and use should 1977 also prove to be a very dry year. Tables contained in this paper are tabulated 1976, 1977, and 1978 April-July water year forecasts versus the observed flows for major Central Valley and east side Sierra Nevada streams. (See also W90-04308)(Lantz-PTT)
W90-04326

HYDROLOGY AND ENVIRONMENTAL ASSESSMENTS.
EMANCO, Inc., Houston, TX.
A. D. Ray, W. P. Wenstrom, and D. D. Taylor.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 387-390.

Descriptors: *Water resources data, *Water resources development, *Environmental impact statement, *Hydrology, *Management planning, Policy making, Decision making.

Most of the current concerns of the hydrologist continue to be related to water quantity, power demand, irrigation water demands, floods and their prevention, recreation and related activities. Attention necessarily has been given to the economics of a given project, but the study of alternatives to a given project traditionally has been based generally on technical and economic considerations only. However, it is important to note that hydrology, as all other technical fields, must adapt to the chal-

lenges posed by our changing social world. There has been an increasing public awareness of all aspects of our society in recent years, resulting in demands of the public to be both informed and involved in decision making of social relevance. The National Environmental Policy Act (NEPA) also required that methods and procedures be identified and developed such that presently unquantified environmental amenities and values may be given appropriate consideration in decision making. This means that water related projects can no longer be built solely on economic and technical considerations; broader environmental aspects also must be considered. The guidelines governing the organization of materials making up an environmental impact statement for a proposed project were arranged in the following sequence: a description of the proposed action, a description of the existing environment and the environmental impact of the proposed action on that environment. Opposition to a project need not be inspired by genuine environmental concern, and the environmental impact statement is a document which can be attacked by anyone; an indefensible statement can be the cause for defeat of a needed project. This observation results in the need for competent and professional preparation of environmental impact statements. (See also W90-04398) (Lantz-PTT)
W90-04335

DATA GATHERING FOR STORMWATER RUNOFF AND SURVEILLANCE.
Geological Survey, Reston, VA. Water Resources Div.
D. J. Lystrom.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 90-104, 2 fig, 4 tab.

Descriptors: *Water pollution sources, *Urban hydrology, *Water pollution control, *Storm runoff, *Data acquisition, *Water quality management, *Urban runoff, Water quality, Management planning, Costs, Pollutant identification, Water pollution effects.

A program is being formulated to collect data to quantify the sources of urban pollutants and to describe their migration to the receiving waters. The objectives of the program should be: (1) Determine the basic processes that affect the quality of urban runoff; (2) Provide a data baseline condition that will serve as a basis for measuring progress in control of urban runoff pollution; (3) Standardize the technique for collection of data related to the quality of urban runoff; (4) Provide data that can be used to evaluate the cost and benefits of various technical management and treatment alternatives; (5) Determine the effectiveness of best management practices (BMPs) in reduction of pollution loads; (6) Assess the degree to which data is transferable from one area to another; and (7) Provide information that is complementary to studies on the effects of urban runoff on receiving water quality and biota. The proposed national data collection program to be funded by the USGS and the US EPA was endorsed. That program includes the measurement of the following types of data on selected urban watersheds: meteorological, storm runoff, quality of storm runoff, atmospheric fallout, watershed activities that affect runoff quality, and basin characteristics. (See also W90-04338)(Lantz-PTT)
W90-04349

DATA GATHERING FOR NPS AND ILLEGAL DISCHARGES.
Metropolitan Sanitary District of Greater Chicago, IL. Dept. of Research and Development.
R. Lanyon.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 177-186.

Descriptors: *Urban hydrology, *Water pollution sources, *Water pollution control, *Nonpoint pollution sources, Chicago, Outfall sewers, Spills, Public participation, Monitoring, Waste recovery, Economic aspects.

The experience of the Metropolitan Sanitary District of Chicago in an inventory of sources of pollutants as a Water Pollution Control Act Section 208 designated agency is described. Numerous sources of uncontrolled pollutants include unknown outfalls to waterways, illegal dumping and unintentional spills. Illegal or inadvertent pollution of water courses by dispersed or unknown sources is a general problem. However, in Chicago it has been found that direct dumping of wastes into watercourses is much less common than similar dumping into sewers. Interjurisdictional collaboration in control of illegal dumping has been achieved on an informal basis, but formal agreements are difficult to make. Citizen assistance (volunteers) in surveillance has been effective in some urban areas. Telephone programs to receive citizen complaints of dumping have also been used successfully. Training of policemen and firemen in illegal dumping surveillance is also effective. Monitoring of toxic substances in sewer lines and tracing of sources is a major and costly program responsibility in industrialized areas. Specialized sampling and analytical instruments are needed. Recovery and disposal of wastes from industrial pretreatment is a gap which must be filled and it can probably best be done by the states. Good site approval processes for pretreatment facilities will help avoid unnecessary hazards to groundwater and surface water supplies. There is still a need for low cost automatic toxic substance monitoring and sampling instrumentation. (See also W90-04338)(Lantz-PTT)
W90-04358

MONITORING OF CONSTRUCTED WETLANDS FOR WASTEWATER.
Environmental Protection Agency, Athens, GA. Environmental Services Div.
For primary bibliographic entry see Field 5D.
W90-04430

7C. Evaluation, Processing and Publication

HYDRAULIC MODELING FOR PALEOFLOOD ANALYSIS.
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2E.
W90-03684

PALEOHYDROLOGIC RECONSTRUCTION OF FLOOD FREQUENCY ON THE ESCALANTE RIVER, SOUTH-CENTRAL UTAH.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 2E.
W90-03685

USE OF CARTOGRAPHIC SOURCES FOR ANALYSING RIVER CHANNEL CHANGE WITH EXAMPLES FROM BRITAIN.
Portsmouth Polytechnic (England). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W90-03694

CARTOGRAPHY OF RIVERS IN FRANCE.
Lyon-3 Univ. (France).
For primary bibliographic entry see Field 2E.
W90-03695

EVOLUTION OF THE PO RIVER: AN EXAMPLE OF THE APPLICATION OF HISTORIC MAPS.
Pavia Univ. (Italy). Dipt. di Ingegneria del Territorio.
For primary bibliographic entry see Field 2E.
W90-03696

GROUNDWATER SENSITIVITY MODELING USING GIS TECHNOLOGY.
Mississippi Research and Development Center, Jackson.
For primary bibliographic entry see Field 5G.
W90-03711

REGIONAL SKEW COEFFICIENTS FOR FLOOD-FREQUENCY ANALYSIS OF MISSISSIPPI STREAMS.
Geological Survey, Jackson, MS. Mississippi District.
For primary bibliographic entry see Field 2E.
W90-03721

APPARENT CHANGES IN THE POTENTIOMETRIC SURFACES OF CRETACEOUS AND PALEOZOIC AQUIFERS OF NORTHEASTERN MISSISSIPPI, 1955-1988.
Mississippi Bureau of Pollution Control, Jackson.
For primary bibliographic entry see Field 2F.
W90-03723

GROUNDWATER EXTRACTION TRENDS IN FOREST AND LAMAR COUNTIES, MISSISSIPPI.
University of Southern Mississippi, Hattiesburg. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-03724

PRELIMINARY STEADY-STATE SIMULATION OF GROUNDWATER FLOW IN HINDS, MADISON, AND RANKIN COUNTIES, CENTRAL MISSISSIPPI.
Mississippi Bureau of Land and Water Resources, Jackson.
For primary bibliographic entry see Field 2F.
W90-03725

POTENTIOMETRIC SURFACES OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER IN EASTERN ARKANSAS, SPRING 1972 AND 1980.
Geological Survey, Little Rock, AR. Water Resources Div.
D. J. Ackerman.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4075, September 1989. 1 map sheet, 4 fig, 17 ref.

Descriptors: *Potentiometric level, *Groundwater level, *Water level, *Arkansas, *Alluvial aquifer, *Maps, Groundwater, Mississippi River Valley.

Maps that show contours of the altitude of water levels for wells completed in the Mississippi River Valley alluvial aquifer in eastern Arkansas were prepared using water-level measurements made in the spring of 1972-1980. Hydrographs for selected wells are included to show trends and lack of trends in water-level changes. The aquifer consists of gravel and sand in flood-plain and terrace deposits of Quaternary age. The aquifer supplies much of the water used for irrigation and aquaculture in eastern Arkansas. A large depression in the potentiometric surface caused by pumping for irrigation and aquaculture occurs in Arkansas, Lonoke, and Prairie Counties. A smaller depression in the potentiometric surface occurs north of Brinkley. Significant water-level declines occurred during the period 1972-80 in several counties west of Crowleys Ridge. (USGS)
W90-03753

GM SYSTEM USERS MANUAL GEOSYNTHETIC MODELING SYSTEM; CSC VERSION 1.00.
Computer Sciences Corp., Cincinnati, OH.
For primary bibliographic entry see Field 5E.
W90-03762

MODELLING COMPONENT.
Tetra Tech, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5B.
W90-03797

DOCUMENTATION OF COMPUTER PROGRAMS TO COMPUTE AND DISPLAY PATHLINES USING RESULTS FROM THE U.S. GEOLOGICAL SURVEY MODULAR THREE-DIMENSIONAL FINITE-DIFFERENCE GROUND-WATER FLOW MODEL.
Geological Survey, Reston, VA.
D. W. Pollock.
Available from the Books and Open FIle Report Section, USGS, Vol 25425, Denver, CO. 80225. USGS Open File Report 89-381, 1989. 188p, 16 fig, 8 tab, 8 ref, 6 append.

Descriptors: *Data interpretation, *Computer programs, *Groundwater movement, Model studies, Finite difference methods, Flow profiles, Flow pattern, MODPATH, MODPATH-PLOT, Graphical analysis.

A particle tracking post-processing package was developed to compute three-dimensional path lines based on output from steady-state simulations obtained with the U.S. Geological Survey modular 3-dimensional finite difference groundwater flow model. The package consists of two FORTRAN 77 computer programs: (1) MODPATH, which calculates pathlines, and (2) MODPATH-PLOT, which presents results graphically. MODPATH uses a semi-analytical particle tracking scheme. The method is based on the assumption that each directional velocity component varies linearly within a grid cell in its own coordinate direction. This assumption allows an analytical expression to be obtained describing the flow path within a grid cell. Given the initial position of a particle anywhere in a cell, the coordinates of any other point along its path line within the cell, and the time of travel between them, can be computed directly. Data is input to MODPATH and MODPATH-PLOT through a combination of files and interactive dialogue. Examples of how to use MODPATH and MODPATH-PLOT are provided for a sample problem. Listings of the computer codes and detailed descriptions of input data format and program options are also presented. (Author's abstract)
W90-03815

METHOD FOR ESTIMATING THE WATER-TABLE ALTITUDE IN A COASTAL-PLAIN AQUIFER USING A GEOGRAPHIC INFORMATION SYSTEM.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W90-03822

EFFECTS OF CLIMATE CHANGE ON WATERSHED RUNOFF.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2A.
W90-03824

SIMULATION OF PRECIPITATION BY WEATHER-TYPE ANALYSIS.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2B.
W90-03825

GEOGRAPHIC INFORMATION SYSTEM/WATERSHED MODEL INTERFACE.
Geological Survey, Towson, MD. Water Resources Div.
G. T. Fisher.
IN: Hydraulic Engineering '89 Proceedings, National Conference on Hydraulic Engineering, HY Div, ASCE, New Orleans, Louisiana, August 14-18, 1989. 1989. p 851-856, 2 fig, 5 ref.

Descriptors: *Data interpretation, *Watersheds, *Hydrologic models, *Geographic information systems, *Model studies, Information systems, Computers, Patuxent River, Maryland, Computer models.

Geographic information systems (GIS) allow for the interactive analysis of spatial data related to water resources investigations. A conceptual design for an interface between a geographic information system and a watershed model includes functions for the estimation of model parameter values. Design criteria include ease of use, minimal equipment requirements, a generic database management system, and use of a macro language. An application was demonstrated for a 90.1 sq km subbasin of the Patuxent River near Unity, Maryland, that performs automated derivation of watershed parameters for hydrologic modeling. A previously developed Hydrologic Simulation Program-Fortran (HSPF) model of the Unity subbasin was calibrated for the period 1978-82 for use in a training workshop. Conventional techniques were used to develop the model parameters. The standard estimate of error (SEE) indicates the average deviation of about two-thirds of the data from a line of perfect agreement. A GIS approach was used to calculate values for most of the basic HSPF hydrologic parameters. in the original model, segmentation for the model was based on land use, except that the GIS approach provided greater detail on land-use type and spatial distribution. In all cases, the coefficients of determination and the standard estimate of error indicate that there is reasonable agreement between observed and simulated monthly flow. This analysis demonstrates that acceptable initial hydrologic parameter estimates for HSPF can be easily and quickly developed using a GIS-based approach. (See also W90-03824) (Lantz-PTT)
W90-03826

MODELING PETROLEUM PRODUCTS IN SOILS.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 5B.
W90-03835

MOVEMENT AND RETENTION OF ORGANICS IN SOIL: A REVIEW AND A CRITIQUE OF MODELING.
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5B.
W90-03836

APPLICABILITY OF POSSM TO PETROLEUM PRODUCT SPILLS.
CH2M/Hill, Bellevue, WA.
For primary bibliographic entry see Field 5B.
W90-03837

UTILITY OF ENVIRONMENTAL FATE MODELS TO REGULATORY PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 5B.
W90-03838

WATER RESOURCES INVESTIGATIONS IN TENNESSEE: PROGRAMS AND ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY, 1988-89.
Geological Survey, Nashville, TN. Water Resources Div.
F. Quinones, B. H. Balthrop, and E. G. Baker.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-379, 1989. 59p, 3 tab.

Descriptors: *Groundwater, *Surface water, *Water quality, *Suspended sediments, *Water use, *Water resources data, *Flood frequency, *Tennessee, Hydrologic data, Data collections.

This report contains a summation of water resources projects which were active in the Tennessee District during 1988 or 1989. Given in each summary is the name of the project chief, the objective of the project, the progress of results of the study to date, and the name of the cooperator. The basic data programs conducted by the Tennessee District provide streamflow, quality of water, and groundwater levels information essential to the assessment and management of the State's water resources. Long-term streamflow, quality of water, and groundwater levels networks are operated as part of the Hydrologic Data Section. Field operations are about equally divided among field offices in Memphis, Nashville, and Knoxville. The data collected as part of the networks are published in the series of annual data reports entitled 'Water Resources Data for Tennessee'. (USGS)
W90-03875

CONSTRUCTION DATA AND RETRIEVAL PROCEDURES FOR SELECTED WELLS DRILLED FROM 1985 THROUGH 1987 AT OAK RIDGE NATIONAL LABORATORY, TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-03878

SIMPLE MODEL OF DROPLET SPECTRAL EVOLUTION DURING TURBULENT MIXING.
Washington Univ., Seattle. Geophysics Program.
J. B. Jensen, and M. B. Baker.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 18, p 2812-2829, September 15, 1989. 12 fig, 2 tab, 38 ref.

Descriptors: *Model studies, *Atmospheric water, *Atmospheric physics, *Air circulation, *Water vapor, *Evaporation, Eddies, Atmosphere, Clouds, Hydrologic cycle, Turbulent flow, Spectral analysis.

The mixing of cloudy, saturated air with cloud-free, subsaturated air is examined with a simple one-dimensional model of the mixing process. The model incorporates (1) a one-dimensional parameterization of turbulent deformation, (2) molecular diffusion, (3) sedimentation of droplets, and (4) droplet evaporation in the changing humidity field. The model predicts droplet shapes after homogenization of the two air masses. The turbulent deformation parameterization is based on inertial subrange arguments. It yields a crude estimate of the time development of the vapor and temperature fields in a single characteristic eddy in one dimension rather than the full range of eddy scales in three dimensions. For the high turbulence levels commonly found in cumuli, the evaporation process appears close to that described earlier as homogeneous, which may in part be due to the approximations in the present treatment. For all other conditions, the calculations show total evaporation of some drops accompanied by some change in droplet spectral shape. (Author's abstract)
W90-03899

PHYSICAL PROCESSES IN POLAR STRATOSPHERIC ICE CLOUDS.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
For primary bibliographic entry see Field 2B.
W90-03902

REGRESSION MODELS FOR ESTIMATING URBAN STORM-RUNOFF QUALITY AND QUANTITY IN THE UNITED STATES.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 5B.
W90-03904

MODELING SOLUTE TRANSFER FROM SOIL TO SURFACE RUNOFF: THE CONCEPT OF EFFECTIVE DEPTH OF TRANSFER.
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 5B.
W90-03908

SOLUTION OF THE NONLINEAR BOUSSINESQ EQUATION FOR PHREATIC FLOW USING AN INTEGRAL BALANCE APPROACH.
National Geophysical Research Inst., Hyderabad (India).
R. N. Singh, and S. N. Rai.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/

4, p 319-323, August 1989. 1 fig, 13 ref.

Descriptors: *Soil water, *Infiltration, *Mathematical studies, *Mathematical equations, *Groundwater movement, *Water table, *Groundwater recharge, Geohydrology, Aquifers, Spatial distribution, Temporal distribution, Drainage ditches, Water table rise.

An analytical solution of the nonlinear Boussinesq equation is presented using the integral balance method. The solution obtained is the same as that obtained by Basak (1979), following a different approach. Basak's solution is based on the assumption that the rate of rise or decline of the phreatic surface in an aquifer bounded by two parallel ditches is constant throughout the aquifer and is a function of time only. This approach assumes variable recharge rates. The solution is derived by averaging the governing equation along the length of the aquifer to predict spatio-temporal distribution of phreatic surface in a ditch drainage system. The present solution is shown to be the same as that of Basak. (Friedmann-PTT)
W90-03909

COMPARISON OF TWO HYDROLOGIC MODELS FOR STEEPLY SLOPING FORESTED WATERSHEDS.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03910

PHYSICS VERSUS MATHEMATICS IN GROUNDWATER FLOW: A PHYSICAL EXPLANATION OF THE MINIMUM THEOREM IN FINITE ELEMENT CALCULATIONS.
W. H. van der Molen.
Journal of Hydrology JHYDA7, Vol. 109, No. 3/4, p 387-388, August 1989.

Descriptors: *Mathematical studies, *Model studies, *Groundwater movement, *Finite element method, *Solute transport, *Hydrologic properties, Geohydrology, Mathematical equations, Fluid flow, Physical properties.

An example is given of a case in which a physical explanation of a problem in two-dimensional transport phenomena may be easier to understand than a mathematical explanation. The case of such transport phenomena in a homogeneous and isotropic medium are often solved mathematically by finite element methods, usually based on the calculus of variations, where it is proven through a solution of the fundamental Laplace equation. The mathematical proof is rather elaborate. The physical explanation, however, is simple if it is supposed that: (1) the changes in kinetic energy are negligible; (2) the flow is such that the dissipation of energy is minimal; and (3) the density of the fluid and the acceleration of gravity are constant. In teaching groundwater hydrology, this physical explanation may serve to explain the principal involved. If desired, it can be followed by the mathematical proof of the theorem. (Friedmann-PTT)
W90-03913

ESTIMATION OF RAINFALL IN BURKINA FASO USING THE ESOC PRECIPITATION INDEX.
European Space Operations Centre, Darmstadt (Germany, F.R.).
For primary bibliographic entry see Field 2B.
W90-03914

OBSERVED AND MODELED TREND OF SULFATE AND NITRATE IN PRECIPITATION IN EASTERN NORTH AMERICA.
Massachusetts Inst. of Tech., Cambridge. Energy Lab.
For primary bibliographic entry see Field 5B.
W90-03935

DEVELOPMENT OF COMPUTER USAGE IN A UK WATER COMPANY.
North Surrey Water Co., Staines (England).
J. Bowyer-Lowe.
Aqua AQUAAA, Vol. 38, No. 1, p 43-51, February 1989. 2 fig, 7 ref.

Descriptors: *Water treatment facilities, *England, *Computers, *Utilities, *Data processing, North Surrey Water Company, Cost analysis, Economic aspects, Management planning, Performance evaluation.

The progress that the North Surrey (England) Water Company has made in the past 20 years in several key areas of technological change and the impact of these changes on the company's operations are reviewed. Areas discussed include: water treatment processes; instrumentation and control; record keeping; leakage control; automatic control; computers in the office; microcomputers in the office; digital record keeping techniques; and the operational control system (philosophy, personnel, scheduling, operation of slow sand filters, operational data analysis, and plant modifications); and optimization of pump scheduling; and developments anticipated over the next 5-10 years. The Water Company has been both careful and fortunate in its choice of advisors, and the catalytic action of in-house expertise has led to the benefits of high cost-effectiveness, modest capital outlay, and economical running costs, coupled with flexibility for the future. Systematic, staged approaches have set out practical programs for completion and the resulting systems have met their objectives, with capital and running costs substantially below those of comparable systems. (Rochester-PTT)
W90-03963

HYDROPOWER OPTIMIZATION VIA SEQUENTIAL QUADRATIC PROGRAMMING.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3E.
W90-03975

DECISION SUPPORT FOR ESTUARINE WATER QUALITY MANAGEMENT.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-03978

COMPARISON OF METHOD OF RESIDUALS AND CLUSTER ANALYSIS FOR FLOOD REGIONALIZATION.
Louisville Univ., KY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-03979

DESIGN OF DILUTION JUNCTIONS FOR WATER QUALITY CONTROL.
Technion - Israel Inst. of Tech., Haifa. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 5F.
W90-03982

RUNOFF MODELING UNDER NOISE-CORRUPTED RAINFALL CONDITIONS.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.
W90-04021

KALMAN FILTER MODELING OF SPACE-TIME RAINFALL USING RADAR AND RAINGAUGE OBSERVATIONS.
Ottawa Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-04024

POOL-ORIFICE AND POOL-ORIFICE-WEIR FISHWAYS.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8I.
W90-04025

COMPUTER PROGRAM DESIGN FOR LAND TREATMENT SYSTEMS.
Clemson Univ., SC.
For primary bibliographic entry see Field 5E.
W90-04086

ANALYTIC SOLUTIONS FOR TIDAL MODEL TESTING.
Systech Engineering, Inc., Lafayette, CA.
For primary bibliographic entry see Field 8B.
W90-04128

EXPERIMENTAL TESTING OF MATHEMATICAL MODELS DESCRIBING THE ENTIRE CYCLE OF FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W90-04149

WQSTAT II: A WATER QUALITY STATISTICS PACKAGE.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
J. C. Loftis, R. D. Phillips, R. C. Ward, and C. H. Taylor.
Groundwater GRWAAP, Vol. 27, No. 6, p 866-873, November-December 1989. 9 fig, 17 ref. Colorado Experiment Station project 0349 and EPA Agency Cooperative Agreement No. CR-813997-01-0.

Descriptors: *Statistics, *Computer programs, *Water quality control, *Water quality management, *Data processing, Computer models, Monitoring, Statistical analysis, Water quality standards.

Statistical analysis of monitoring data is becoming a necessary part of many groundwater and surface-water quality management activities. To meet this need a statistical software package for microcomputers called WQStat II has been designed and produced specifically for water quality applications. The software provides tools for data management, summarizing data characteristics, analyzing trends, comparing medians of two or more groups of data, and evaluating excursions or standards violations. To minimize problems associated with nonnormal data and nondetects, WQStat relies primarily on graphical and nonparametric approaches. The use of nonparametric methods reduces but does not eliminate the need to consider underlying assumptions regarding data characteristics. All of the techniques in WQStat II are based on assumptions of the nature of the random variables of interest under the null hypothesis. (Author's abstract)
W90-04165

COMPUTER NOTES--ON ANALYSIS OF STEP-DRAWDOWN DATA.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
A. D. Gupta.
Groundwater GRWAAP, Vol. 27, No. 6, p 874-881, November-December 1989. 1 fig, 6 tab, 10 ref.

Descriptors: *Computer programs, *Wells, *Pumping tests, *Aquifers, Data processing, Drawdown, Computer models, Groundwater movement, Mathematical equations.

A method is described for the analysis of step-drawdown pumping test data that uses the general form of the drawdown equation during a step with the superposition of the effects of incremental pumping between steps. An interactive computer code based on this procedure is developed to estimate aquifer characteristics and well-loss factor from the observed time-drawdown data at different discharge rates. Analysis with a specific set of data taken from the literature indicates that it is not imperative that the exponent of discharge for well-loss component should be treated as unknown. By assuming $P = 2$, a reasonable estimate of parameters for predicting the drawdown in this specific case can be obtained. Even by neglecting the effect of the residual drawdown, the simpler analysis

procedure would be adequate to find the initial estimates of the parameters. The appropriateness of a particular method of analysis depends on the data. As such it is important to use several methods of analysis for any test data to find the best-fitting drawdown/discharge relationship needed for the pump design or for the determination of maximum yield. (Author's abstract)
W90-04166

WATER QUALITY MODEL CALIBRATION: A COMPARISON OF INPUT AND OUTPUT ERROR CRITERIA.
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5B.
W90-04172

MODEL FOR PREDICTING TRANSPORT OF PESTICIDES AND THEIR METABOLITES IN THE UNSATURATED ZONE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-04173

GENERATION OF SYNTHETIC AND MISSING CLIMATIC DATA FOR PUERTO RICO.
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2D.
W90-04180

ESTIMATING MEAN AND VARIANCE FOR ENVIRONMENTAL SAMPLES WITH BELOW DETECTION LIMIT OBSERVATIONS.
Savannah River Ecology Lab., Aiken, SC.
M. C. Newman, P. M. Dixon, B. B. Looney, and J. E. Pinder.
Water Resources Bulletin WARBAQ, Vol. 25, No. 4, p 905-916, August 1989. 3 fig, 1 tab, 43 ref.

Descriptors: *Data interpretation, *Monitoring, *Environmental data, *Detection limits, *Statistical analysis, *Water quality, Computer models, Data estimation.

Left-censoring of data sets complicates subsequent statistical analyses. Generally, substitution or deletion methods provide poor estimates of the mean and variance of censored samples. These substitution and deletion methods include the use of values above the detection limit (DL) only, or substitution of 0, DL/2 or the DL for the below DL values during the calculation of mean and variance. A variety of statistical methods provides better estimators for different types of distributions and censoring. Selected statistical methods applicable to left-censoring of environmental data sets are reviewed with the purpose of demonstrating the use of these statistical methods for coping with Type I (and Type II) left-censoring of normally and log-normally distributed environmental data sets. Restricted maximum likelihood estimates are easily computable, are less biased and more accurate than the other estimators when the parent distribution is known. The robustness of regression of normal scores after log transformation of the data suggests that these methods are the most effective when a parent distribution cannot be identified. UNCENSOR, a public domain Pascal program, is available for application of maximum likelihood and order statistics methods to normal and 2-parameter log-normal sets. Methods for coping with multiple detection limit censoring of environmental data sets remains ill-defined, and further work is needed. (Author's abstract)
W90-04188

COMPARISON OF IN SITU AND LANDSAT DERIVED REFLECTANCE OF ALASKAN GLACIERS.
National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.
For primary bibliographic entry see Field 2C.
W90-04190

MODELING FUTURE TRENDS IN WETLAND LOSS AND BROWN SHRIMP PRODUCTION IN LOUISIANA USING THEMATIC MAPPER IMAGERY.
National Marine Fisheries Service, Miami, FL. Southeast Fisheries Center.
For primary bibliographic entry see Field 2L.
W90-04192

ANALYSIS OF THEMATIC MAPPER DATA FOR STUDYING THE SUSPENDED MATTER DISTRIBUTION IN THE COASTAL AREA OF THE GERMAN BIGHT (NORTH SEA).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 2J.
W90-04193

MONITORING SEDIMENT TRANSPORT SYSTEMS IN A SEMIARID AREA USING THEMATIC MAPPER DATA.
Reading Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-04196

STAGE DISTRIBUTION APPROACH TO ESTIMATING ICE RELATED FLOODING PROBABILITIES.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W90-04199

COMPARISON OF REGRESSION AND TIME-SERIES METHODS FOR SYNTHESIZING MISSING STREAMFLOW RECORDS.
Oak Ridge National Lab., TN.
J. J. Beauchamp, D. J. Downing, and S. F. Railsback.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 961-975, October 1989. 8 fig, 4 tab, 9 ref. DOE Contract No. DE-AC05-84OR21400.

Descriptors: *Streamflow data, *Regression analysis, *Time series analysis, *Streamflow forecasting, *Surface water records, Data requirements, Estimation techniques.

Regression and time-series techniques have been used to synthesize and predict the stream flow at the Foresta Bridge gage from information at the upstream Pohono Bridge gage on the Merced River near Yosemite National Park. Using the available data from two time periods (calendar year 1979 and water year 1986), the two techniques were evaluated in their ability to model the variation in the observed flows and in their ability to predict stream flow at the Foresta Bridge gage for the 1979 time period with data from the 1986 time period. Both techniques produced reasonably good estimates and forecasts of the flow at the downstream gage. However, the regression model was found to have a significant amount of autocorrelation in the residuals, which the time-series model was able to eliminate. The time-series technique presented can be of great assistance in arriving at reasonable estimates of flow in data sets that have large missing portions of data. (Author's abstract)
W90-04200

APPLICATION OF THE U.S.G.S. DIFFUSION HYDRODYNAMIC MODEL FOR URBAN FLOODPLAIN ANALYSIS.
Williamson and Schmid, Irvine, CA.
For primary bibliographic entry see Field 2E.
W90-04212

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLUME 3D AND UNCERTAINTY.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
For primary bibliographic entry see Field 5B.
W90-04216

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLUME, CROSS-SECTION, AND RECHARGE.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
For primary bibliographic entry see Field 5B.
W90-04217

MODELING GROUND WATER AND POLLUTION--THE ROLE OF THE DESKTOP COMPUTER IN THE DECISION-MAKING PROCESS: PLASM AND RANDOM WALK.
Oklahoma State Univ., Stillwater. Univ. Center for Water Research.
For primary bibliographic entry see Field 5B.
W90-04218

STATISTICAL ANALYSIS OF GROUND-WATER MONITORING DATA AT RCRA FACILITIES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 7A.
W90-04250

PREDICTION METHODOLOGY FOR CONTAMINANT TRANSPORT FROM RANGELAND WATERSHEDS.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5B.
W90-04253

COMPUTER METHODS AND WATER RESOURCES: FIRST INTERNATIONAL CONFERENCE, MOROCCO 1988.
For primary bibliographic entry see Field 8B.
W90-04274

SPECTRAL ANALYSIS IN COMPUTATIONAL FLUID MECHANICS: DEVELOPMENT OF A NUMERICAL APPROACH.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04275

TREATMENT OF BODY FORCE INTEGRALS IN BOUNDARY ELEMENTS.
Computational Mechanics Inst., Southampton (England).
For primary bibliographic entry see Field 8B.
W90-04276

PARALLEL DECOMPOSITION IN THE OPTIMIZATION OF LARGE SCALE SYSTEMS SUBJECT TO SEVERAL CONDITIONS OF BEHAVIOR.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
For primary bibliographic entry see Field 8C.
W90-04277

SPECTRAL FINITE ANALYTICAL NUMERICAL METHOD FOR THREE-DIMENSIONAL UNSTEADY NAVIER-STOKES EQUATIONS.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
For primary bibliographic entry see Field 8B.
W90-04278

PRECONDITIONED CONJUGATE GRADIENT METHOD FOR NUMERICAL SOLUTION OF NAVIER-STOKES EQUATIONS.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
For primary bibliographic entry see Field 8C.
W90-04279

IMPLICIT NUMERICAL MODELING OF UNSTEADY FLOW IN THE TIGRIS-DIYALAH CONFLUENCE.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W90-04280

APPLICATION OF THE BOUNDARY ELEMENT METHOD TO SOME ELLIPTIC FLUID MECHANICS PROBLEMS.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04281

CLASSICAL METHODS AND PARAMETERS OF SPECTRAL ANALYSIS. DESCRIPTION AND IMPLEMENTATION(METHODES CLASSIQUES ET PARAMETRIQUES D'ANALYSE SPECTRALE. DESCRIPTION ET MISE EN OEUVRE).
Centre Univ. de Luminy, Marseille (France). Inst. de Mecanique Statistique de la Turbulence.
For primary bibliographic entry see Field 8B.
W90-04282

USE OF A MIXED SPECTRAL-FINITE ANALYTIC NUMERICAL TECHNIQUE FOR THE ANALYSIS OF THE VORTEX SHEDDING PAST A CIRCULAR CYLINDER.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04283

BOUNDARY ELEMENT APPROACH TO ONE-DIMENSIONAL WAVE EQUATION.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco). Hydraulic Dept.
For primary bibliographic entry see Field 8B.
W90-04284

APPLICATIONS OF THE METHOD OF FUNDAMENTAL SOLUTIONS IN WATER RESOURCES.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
For primary bibliographic entry see Field 8B.
W90-04285

NUCLEOLAR PROGRAMMING FOR CONVEX MULTICRITERIA OPTIMIZATION.
Universidad Nacional de San Luis (Argentina). Inst. de Matematica Aplicada.
E. Marchi, and J. A. Oviedo.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 163-171, 7 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Optimization, *Computers, *Mathematical studies, Algorithms.

A nucleolar solution is introduced and used to study the problem of convex multicriteria optimization. This method differs from traditional lexicographic methods where the order for maximizing and minimizing is arbitrary. The nucleolar solution approach allows the particular lexicographic order to be specified. A nucleolar algorithm also is introduced. (See also W90-04274) (Hammond-PTT)
W90-04286

ARTIFICIAL INTELLIGENCE APPLICATIONS IN ENGINEERING DESIGN: RESEARCH AT M.I.T.
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 8A.
W90-04287

SEDEC; A SEDIMENT ECONOMICS SIMULATION MODEL.
Illinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 4D.
W90-04288

SAPHO20: AN AID IN WATER PLANNING(SAPHO20: SYSTEME D'AIDE A LA PLANIFICATION DE L'EAU).
Grenoble-2 Univ. (France). Centre de Recherche en Informatique Appliquee aux Science Sociales.
For primary bibliographic entry see Field 6A.
W90-04289

COMPUTER AIDED MANAGEMENT OF WATER RESOURCES SYSTEMS.
Politechnika Warszawska (Poland). Inst. of Environmental Engineering.
For primary bibliographic entry see Field 6A.
W90-04290

CAD IN THE DESIGN OF PIPELINES FOR IRRIGATION SCHEMES.
Lotti (C.) and Associates, Rome (Italy).
For primary bibliographic entry see Field 8A.
W90-04291

REPRO: HYDRAULIC NETWORK DESIGN.
Lotti (C.) and Associates, Rome (Italy).
For primary bibliographic entry see Field 8A.
W90-04292

SIMPLE SYSTEM TO MANAGE A HYDROLOGICAL DATA BASE - APPLICATION OF PERSONAL COMPUTERS(UN SYSTEME SIMPLE DE GESTION D'UNE BASE DE DONNEES HYDROLOGIQUES - APPLICATION POUR ORDINATEURS PERSONNELS).
Institut Royal Meteorologique de Belgique, Brussels. Hydrology Section.
G. L. Dupriez, and X. Moons.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 245-257, 2 fig, 4 tab, 8 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Databases, *Hydrologic data collections, *Computers, *Data storage and retrieval, Automation.

The World Meteorologic Organization program, which was initially developed for main frame computers, has been recently re-written for personal computers. This development permits the tapping of hydrological technology by using a multipurpose operational hydrological subprogram (SHOFM), the scope of which is the transfer of technology in the field of hydrology. Most of the applications proposed in SHOFM are based on the architecture of SGHBDH (Management System for Hydrological Data Base), which consists of a series of operational files one of which is a functional 'transfer' file. This transfer file serves as a crucial element in the acquisitioning of specific hydrological data by personal computers in various working hydrological stations. (See also W90-04274) (Peters-PTT)
W90-04293

SHARING OF SIMULATION TOOLS AND TRANSFER OF TECHNOLOGY.
Centre de Formation, de Recherche et d'Essais Hydrauliques de Grenoble (France).
For primary bibliographic entry see Field 8B.
W90-04294

COMPUTER AIDED DESIGN SOFTWARE IN FLUVIAL HYDRAULICS: PROGRAM CADRIV.
Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04295

SIMPLE NUMERICAL MODELS FOR COASTAL POWER PLANTS PROJECTS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 8B.
W90-04296

COMPUTER AIDED OPERATION OF IRRIGATION SYSTEMS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 3F.
W90-04297

MEASUREMENT AND ANALYSIS OF DYNAMIC PRESSURES ON HYDRAULIC MODELS.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 8B.
W90-04298

DETERMINATION OF DESIGN EVENTS FOR PRECIPITATION USING THE TIME-VARIABLE DATA RECORDING METHOD.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
For primary bibliographic entry see Field 2B.
W90-04299

GROUNDWATER DATA ACQUISITION AND PROCESSING AT TWO RECHARGE DAMS.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W90-04300

SIMILARITIES AND DIFFERENCES IN THE NATURE OF GROUND AND SURFACE WATER DATA AND THE IMPLICATIONS FOR DESIGNING PERSONAL COMPUTERS DATA SYSTEMS.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W90-04301

EARTHQUAKES AND HYDRODYNAMIC PRESSURES ON STRUCTURES.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04302

USING SUPER COMPUTERS FOR THE TIME HISTORY ANALYSIS OF OLD GRAVITY DAMS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 8B.
W90-04303

DIRECT BOUNDARY ELEMENT TECHNIQUE FOR COMPUTING WATER WAVES.
North Staffordshire Polytechnic, Stafford (England). Dept. of Mechanical and Computer-Aided Engineering.
For primary bibliographic entry see Field 8B.
W90-04304

RESTORATION OF A CONCRETE TUNNEL LINING: THE ROLE OF FIELD MEASUREMENTS IN THE SAFETY AND CONTROL OF THE STRUCTURAL STABILITY.
Ente Nazionale per l'Energia Elettrica, Rome (Italy).
For primary bibliographic entry see Field 8F.
W90-04305

THERMAL STRESS NUMERICAL ANALYSIS OF A CONCRETE UNDERGROUND DISCHARGE CONTROL.
Istituto Sperimentale Modelli e Strutture S.p.A., Bergamo (Italy).

For primary bibliographic entry see Field 8F.
W90-04306

FLUID-STRUCTURE INTERACTION: EXPERIMENTAL AND NUMERICAL ANALYSES.
Centro Informazioni Studi Esperienze, Milan (Italy).
For primary bibliographic entry see Field 8B.
W90-04307

IMPROVED HYDROLOGIC FORECASTING: WHY AND HOW.
For primary bibliographic entry see Field 2A.
W90-04308

TECHNIQUES FOR THE GENERATION OF LONG STREAMFLOW SEQUENCES.
Hydrocomp, Inc., Palo Alto, CA.
K. M. Leytham, and D. D. Franz.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 20-46, 13 fig, 2 tab, 16 ref.

Descriptors: *Streamflow forecasting, *Streamflow, *Model studies, *Forecasting, *Data interpretation, Statistical methods, Rio Paranaiba, Brazil, Markov process, Flood forecasting, History, Rainfall-runoff relationships.

The goal of data generation in the present context is to generate streamflow sequences which replicate certain important features or statistics of the historic record. Model choice should ideally be based on considerations of the following items: the features or statistics to be preserved; the extent and quality of historic data; the type of distribution followed by historic data; the effects of uncertainty in parameter levels; and the implications of failing to preserve certain statistics or features. A variety of models or generators have been presented in the literature and a number of comparative studies have been performed to evaluate several of these models. In general, the models fall into two categories: (1) those that preserve short-term persistence (e.g., Markov); and (2) those that preserve long-term persistence (i.e., Hurst effect). The model outlined in this study is a multi-season, multi-site, lag-one Markov model designed for the generation of monthly data. The model is applied to the Rio Paranaiba watershed in Brazil to generate additional streamflow data at a number of existing stream gage sites for use in operation studies on proposed series of reservoirs. Streamflow data was to be generated at the four stream gage sites Porto Jacinto, Porto de Barra, Cachoeira de Sertao, and Ponte Festelita Campos. Rainfall data was available for a period of 18 years at seven sites within the basin. Despite difficulties encountered in calibration on the Paranaiba, the results from indirect streamflow generation are quite encouraging. Comparison of the statistics of the record and extended record suggest that indirect generation produced a more reliable synthetic sequence than could be obtained from the existing record at Ponte Estelita Campos. However, it is apparent that bias in the calibration will also bias the synthetic streamflow. Until more experience is gained using this approach, it is difficult to say at what point calibration difficulties should force us to use direct streamflow generation. (See also W90-04308)(Lantz-PTT)
W90-04310

PROBLEMS IN OPERATIONAL HYDROLOGIC FORECASTING.
Sierra Hydrotech, Placerville, CA.
For primary bibliographic entry see Field 2E.
W90-04311

TROPICAL STORM SURGE FORECASTING IN THE NATIONAL WEATHER SERVICE.
National Weather Service, Silver Spring, MD. Techniques Development Lab.
For primary bibliographic entry see Field 2L.
W90-04312

DECISION MAKING AND THE COST OF IGNORANCE.
Engineering Decision Analysis Co., Inc., Palo Alto, CA.
For primary bibliographic entry see Field 6A.
W90-04313

HYDROLOGIC UNCERTAINTY AND PROJECT BENEFITS.
Bureau of Reclamation, Sacramento, CA. Mid-Pacific Regional Office.
B. E. Martin, and R. W. Julian.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 84-92, 4 fig.

Descriptors: *Water resources development, *Mathematical models, *Project planning, *Hydrology, *Stochastic hydrology, *Water management, Lake Berryessa, Lake Shasta, Data interpretation, Statistical analysis, History, Reservoirs.

A stochastic analysis was emplyed to examine the impacts of hydrologic uncertainty on lifetime project benefits using two Bureau of Reclamation case examples: (1) an existing reservoir, Lake Berryessa, and (2) a possible future reservoir, an enlarged Lake Shasta. Stochastic hydrology addresses the inability to predict future inflows by examining the probabilistic aspects of the future as derived from the statistical properties of the historical sample. The basic procedure can be summarized as follows: (1) studies are made to determine the underlying statistical properties of the historical inflow. Based on this analysis, a mathematical model is constructed which preserves the historical statistical properties and generates synthetic inflows of any specified duration. By generating many sets or traces of inflow, the reservoir can be operated through a variety of possible inflow patterns, each of which gives a different estimate of project yield and accomplishments. Comparing these yields and accomplishments with the frequency of their occurrence enables one to estimate the risk or probability associated with a specified level of output. In the Berryessa analysis, 100 traces of monthly inflow, each having a duration of 70 years, were generated. In the case of enlarged Shasta, a larger sample containing 1,000 traces of annual inflow was generated, each trace having a duration of 50 years. For the benefit of those familiar with the mathematics of stochastic processes, a lag-one Markov model was used for both cases. Of the two cases, Berryessa, a single-purpose (water supply) reservoir operationally and financially independent of the CVP, is far simpler to analyze. Overall however, stochastic analysis provided useful probabilistic and operational information, although it did not remove hydrologic and related economic uncertainty. In planning a project, assumptions regarding future inflow influence the assumed project benefits. However, inability to forecast the occurrence and magnitude of future droughts dictates a conservative posture with regard to assumed project capabilities and benefits. (See also W90-04308)(Lantz-PTT)
W90-04314

BENEFITS OF UNCERTAINTY: PROBABILITY IN SHORT AND LONG TERM HYDROLOGIC FORECASTING.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
R. L. Bras.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 141-159, 8 fig, 15 ref. NSF Grant ENG 78-20245. National Weather Service Contract 7-35112.

Descriptors: *Flood forecasting, *Streamflow forecasting, *Hydrologic models, *Long-term planning, *Short-term planning, *Forecasting, *Flood discharge, Probabilistic process, Flood plain management.

Engineers and scientists are commonly in the difficult situation of having to predict hydrologic events based on limited knowledge of reality, imperfect models and incomplete data sources. The theory of probability allows explicit consideration of the above uncertainties allowing improved hydrologic modeling. Examples are given where the joint use of probability and physical hydrology permit improved long-term predictions and short-term discharge forecasting. Long-term predictions refer to statements of recurrence of future discharge events. Short-term discharge forecasting deals with daily flood and river stage predictions done by the US National Weather Service. The explicit acknowledgement of uncertainties permits the use of powerful probability theory concepts while at the same time preserving and using valuable deterministic hydrologic formulations. The techniques illustrated were derived distributions and optimal estimation using the Kalman-Bucy filter. It should be clear that the solutions presented, given in terms of physical hydrologic parameters, would have been impossible to obtain without exploiting the tools of probability theory. (See also W90-04308)(Lantz-PTT)
W90-04318

PRECIPITATION FORECASTING AT A NATIONAL CENTER.
National Meteorological Center, Camp Springs, MD. Quantitative Precipitation Branch.
D. A. Olson.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 199-205, 3 fig.

Descriptors: *Meteorology, *Weather forecasting, *Forecasting, *Precipitation, Hydrometeorology, Quantitative analysis, Rainfall, Data interpretation, Prediction.

The National Meteorological Center (NMC) routinely supports all meteorological activities in the U.S., as a World Meteorological Center component of the World Meteorological Organization (WMO). Many of the activities of the NMC support both functions. Activities include data collection, editing, processing and communication. Perhaps the more important functions are analyses, prognoses and specialized forecasts which are best accomplished by a national center--these include world-wide aviation forecasts, generalized medium-range forecasts in the 3-5 and 6-10 day range, and quantitative precipitation and heavy snow forecasting. The Quantitative Precipitation Branch (QPB) of NMC's Forecast Division has prepared and issued forecasts of precipitation amounts (QPF) and snowfall amounts since the early 1960's. The prediction of precipitation amounts is one of the most difficult and challenging aspects of meteorology, yet is an area with promise of great economic benefit. For purposes of verification, a 'best' analysis is constructed using all readily available real-time rainfall data incorporating radar and/or satellite data wherever there are gaps in observed rainfall data. Predicted, observed and correct areas are determined areally. Other measures of forecast performance, which can be computed readily, are the Postagreement--or correctness percentage of the forecast and the Prefigurance, which is the ratio of the observed events which were predicted correctly. Figures readily show the effects of scale on predictability. Research needs to continue in the area of intense small-scale convective rain systems--particularly with emphasis on the prediction of these flash flood producers with several hours lead time. Forecasts need to and can be improved with greater understanding through research, particularly in regard to the magnitude and duration of the rainfall. Although an automated version of precipitation amount probability is currently available, it would be a worthwhile undertaking to investigate the utility of subjective probability estimates. (See also W90-04308)(Lantz-PTT)
W90-04320

BPA HYDROLOGIC FORECASTING CONSIDERATIONS AND ACTIONS DURING THE 1976-77 DROUGHT.
Bonneville Power Administration, Vancouver, WA. Hydrometeorology Section.
W. R. Gordon, C. H. Watkins, and R. C. Lamb.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 274-284, 4 ref.

Descriptors: *Streamflow forecasting, *Bonneville Power Administration, *Drought, *Forecasting, *Water resources management, Powerplants, Energy sources, Streamflow, Water use, Competing use, Industrial water, State jurisdiction, Water management, Governmental interrelations.

The Pacific Northwest is dependent upon its water supply to meet the region's electric energy requirements. Managing the large amount of reservoir storage of this multipurpose system requires frequent and accurate assessments of the water supply, electric energy supply and electric energy requirements to determine the system's hourly, daily, and seasonal load carrying capability. Weather forecasts, streamflow and load forecasting models, and plant scheduling models provide the tools to plan the electric energy supply. Constant coordination among water managers is maintained to achieve optimum use of the region's water for all interests. The drought of 1977 emphasized the need for this coordination. Conflicts of water use among States and agencies during drought resulted in the Governors of the States in the Pacific Northwest to endorse certain water management plans. This was the first time an action of this nature was taken and procedures were established that may be used in future years. As non-renewable energy resources diminish and power requirements increase, more demands will be put on the region's water supply. Optimum management of the region's water is an increasing challenge. (See also W90-04308)(Lantz-PTT)
W90-04325

CONTAMINATION IN THE HYDROLOGIC DATA BASE.
National Weather Service, Sacramento, CA. River Forecast Center.
R. J. C. Burnash, and R. L. Ferral.
IN: Improved Hydrologic Forecasting: Why and How. Proceedings of an Engineering Foundation Conference, Asilomar Conference Grounds, Pacific Grove, California, March 25-30, 1979. American Society of Civil Engineers, New York. 1980. p 303-311, 4 fig.

Descriptors: *Data quality control, *Quality control, *Hydrologic data collections, *Databases, *Error analysis, Data acquisition, Precipitation, Streamflow, Data interpretation, Simulation analysis.

Published and currently collected precipitation and streamflow records are often contaminated by misleading measurements, errors in measurements and changes in measuring techniques. Precipitation data can be particularly misleading due to continued use of a station name through many physical moves of the equipment or when the measuring device is changed. Other subtle sources of database contamination involve changes in the trajectory and/or velocity of the basic airstream. The analysis of precipitation errors becomes more striking in arid regions. There are several techniques for protection from database inconsistencies including double mass plots of precipitation data and cross basin plots of discharge data. The most effective technique starts with these simple tests followed by streamflow simulation. The need for accurate hydrologic data has led to the development of a new family of cost-effective precipitation gages for immediate data acquisition by computer. Efforts in California to automate data collection use these self-reporting gages which send a radio signal to the base station when a change occurs and at timed intervals when no change occurs. These approaches, when coupled with streamflow simulation, should help determine that a gage is not functioning properly. The data identified as contaminated can either be adjusted or excluded and the verified data can be used to produce much more reliable hydrologic analyses and forecasts. (See also W90-04398) (Lantz-PTT)
W90-04328

QUALITATIVE AND QUANTITATIVE AQUATIC ALGAL DATA COMPILATION TO DETERMINE MACROTRENDS-III.
Arkansas Univ., Fayetteville. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 2H.
W90-04492

RELIABILITY OF IMPINGEMENT SAMPLING DESIGNS: AN EXAMPLE FROM THE INDIAN POINT STATION.
Normandeau Associates, Inc., Bedford, NH.
For primary bibliographic entry see Field 8I.
W90-04516

DEVELOPMENT AND SENSITIVITY ANALYSIS OF IMPACT ASSESSMENT EQUATIONS BASED ON STOCK-RECRUITMENT THEORY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 6G.
W90-04519

SOME CONSIDERATIONS IN APPLYING STOCK-RECRUITMENT MODELS TO MULTIPLE-AGE SPAWNING POPULATIONS.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 8I.
W90-04520

TESTING THE VALIDITY OF STOCK-RECRUITMENT CURVE FITS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 8I.
W90-04521

FISHING IN DANGEROUS WATERS: REMARKS ON A CONTROVERSIAL APPEAL TO SPAWNER-RECRUIT THEORY FOR LONG-TERM IMPACT ASSESSMENT.
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
For primary bibliographic entry see Field 8I.
W90-04522

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1984.
Geological Survey, Tuscaloosa, AL. Water Resources Div.
H. C. Rollins, E. G. Ming, F. C. Sedberry, and I. A. Giles.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-159316. Price codes: A15 in paper copy, A01 in microfiche USGS Water-Data Report AL-84 (WRD/HD-85/272), 1985. 327p, Prepared in cooperation with the Alabama Department of Environmental Management and other agencies.

Descriptors: *Hydrologic data, *Alabama, *Surface water, *Data collections, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Alabama consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report contains discharge records for 85 gaging stations; stage at 23 gaging stations, stage and contents for 13 lakes and reservoirs; water quality for 31 gaging stations, 5 wells, 3 precipitation stations, and water levels for 48 observations wells. Also included are 4 crest-stage partial record stations, 6 flood hydrograph partial-record stations and 26 water quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analysis. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alabama. (USGS)
W90-04530

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1984.
Geological Survey, Anchorage, AK. Water Resources Div.
B. B. Bigelow, R. D. Lamke, P. J. Still, J. L. van Maanen, and J. E. Vaill.
Available from the National Technical Information Service, Springfield, VA 2216,. as PB86-164324. Price codes: A16 in paper copy, A01 in microfiche SGS Water-Data Report AK-84-1 (WRD/HD-85/264), 1985. 347p. Prepared in cooperation with the State of Alaska and other agencies.

Descriptors: *Alaska, *Hydrologic data, *Surface water, *Groundwater, *Water quality, *Data collections, Flow rates, Gaging stations, Lakes, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells. This report contains discharge records for 112 gaging stations; water quality for 43 stations; and water levels for 31 observation wells. Also included are 64 crest-stage, and 59 water quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska. (USGS)
W90-04531

WATER RESOURCES DATA FOR ARIZONA, 1983.
Geological Survey, Tucson, AZ.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111308. Price codes: A17 in paper copy, A01 in microfiche USGS Water-Data Report AZ-83-1 (WRD/HD-86/233), 1986. 387p. Prepared in cooperation with the State of Arizona and other agencies.

Descriptors: *Data collections, *Arizona, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1983 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; water levels of observation wells; and quality of groundwater. This report contains discharge records for 208 gaging stations, annual peaks for 24 crest-stage partial-record stations, and discharge measurements at 18 miscellaneous sites; contents only records for 8 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 16 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water quality records for 54 continuous-record stations and 3 miscellaneous sites; water levels for 97 observation wells; and water quality data for water from 132 wells. The data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Federal and State Agencies in Arizona. (USGS)
W90-04532

WATER RESOURCES DATA--ARKANSAS, WATER YEAR 1984.
Geological Survey, Little Rock, AR. Water Resources Div.
T. E. Lamb, J. E. Porter, B. F. Lambert, and J. Edds.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130259. Price codes: A99 in paper copy, A01 in microfiche USGS Water-Data Report AR-84-1 (WRD/HD-85/261), 1985. 623p. Prepared in cooperation with the State of Arkansas and other agencies.

Descriptors: *Data collections, *Arkansas, *Hydrologic data, *Surface water, *Groundwater, *Water quality, *Flow rates, Gaging stations, Lakes, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for Arkansas consist of records of discharge, and water quality of streams; water quality of lakes; water levels and water quality of observation wells. This report contains discharge records of 48 regular surface-water stations; water quality data for 130 regular water quality stations, and 75 partial-record water quality stations; 92 wells with water level measurements, 4 wells with water level and water quality measurements, and 2 wells with water quality data only. Also included are data for 77 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Arkansas. (USGS)
W90-04533

WATER RESOURCE DATA--ARKANSAS, WATER YEAR 1985.
Geological Survey, Little Rock, AR. Water Resources Div.
T. E. Lamb, J. E. Porter, B. F. Lambert, and J. Edds.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-111712/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report AR-85-1 (WRD/HD-86/238), 1986. 523p. Prepared in cooperation with the State of Arkansas and other agencies.

Descriptors: *Data collections, *Arkansas, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Arkansas consist of records of discharge, and water quality of streams; water quality of lakes; water levels and water quality of observation wells. This report contains discharge records for 45 regular surface-water stations; water-quality data for 158 regular water-quality stations, 73 partial-record water-quality stations, 5 observation wells, and 1 precipitation station; water-level measurements for 98 observation wells. Also include are data for 82 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Arkansas. (See also W90-04533) (USGS)
W90-04534

WATER RESOURCES DATA FOR CALIFORNIA, 1983. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
J. C. Bowers, M. T. Butcher, C. E. Lamb, J. A. Singer, and G. B. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-127636. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report CA-83-1 (WRD/HD-85/254), 1985. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *Data collections, *California, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Reservoirs, Lakes, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1983 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 1 contains discharge records for 154 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 20 streams and 18 wells; water levels for 165 observation wells. Also included are 10 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See also W90-04536) (USGS)
W90-04535

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1983 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
S. Anderson, K. L. Markham, V. Piro, W. F. Shelton, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-135332. Price codes: A19 in paper copy, A01 in microfiche USGS Water-Data Report CA-83-2 (WRD/HD-85/237), 1985. 421p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *Data collections, *California, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resource data for the 1983 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 145 gaging stations; stage and contents for 19 lakes and reservoirs; water quality for 17 stations; water levels for 67 observation wells. Also included are two low-flow partial-record stations and 18 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See also W90-04535) (USGS)
W90-04536

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
S. Anderson, K. L. Markham, V. Piro, W. F. Shelton, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-197076. Price codes: A15 in paper copy, A01 in microfiche USGS Water-Data Report CA-84-2, (WRD/HD-86/209), 1985. 315p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *Data collections, *California, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 132 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 11 stations; water levels for 9 observation wells. Also included are two low-flow partial-record stations and 19 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-04535 thru W90-04536 and W90-04538) (USGS)
W90-04537

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984 VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
R. P. Fogelman, T. C. Hunter, J. R. Mullen, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-162500. Price codes: A16 in paper copy, A01 in microfiche USGS Water-Data Report CA-84-3 (WRD/HD-86/210), 1985. 355p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *Data collections, *California, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 3 contains discharge records for 126 gaging stations; stage and contents for 36 lakes and reservoirs; gage height records for 2 lakes; water quality for 9 streams and 40 wells; water levels for 53 observation wells. Also included are 2 crest-stage partial-record stations and 27 water quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-04535 thru W90-04537 and W90-04539) (USGS)
W90-04538

WATER RESOURCES DATA FOR CALIFORNIA, 1984 VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
R. P. Fogelman, J. R. Mullen, W. F. Shelton, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-182036. Price codes: A13 in paper copy, A01 in microfiche USGS Water-Data Report CA-84-4 (WRD/HD-86/228), 1986. 292p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *Data collections, *California, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1984 water year for California consist of records of stage, discharge,

and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 152 gaging stations; stage and contents for 25 lakes and reservoirs; water precipitation data for 2 stations; water quality for 9 stations; water levels for 12 and water quality for 46 observation wells. Also included is one low-flow partial-record station and 19 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-04535 thru W90-04538) (USGS)
W90-04539

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
A. C. Duncan, R. C. Ugland, J. L. Blattner, and R. D. Steger.
Available from the National Technical Information Service, Springfield, VA 22161, as PB96-130648. Price codes: A18 in paper copy, A01 in microfiche USGS Water-Data Report CO-84-1 (WRD/HD-85/243), 1985. 409p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Data collections, *Colorado, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for Colorado for the 1984 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water discharge record for 352 gaging stations, stage and contents of 23 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 32 crest-stage partial record stations, and one miscellaneous site; water quality for 126 gaging stations and 275 miscellaneous sites; and water levels for 55 observation wells. Six pertinent stations in bordering States also are include. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-04541 thru W90-04542) (USGS)
W90-04540

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
A. C. Duncan, R. C. Ugland, J. L. Blattner, and R. G. Kretschman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130655. Price codes: A12 in paper copy, A01 in microfiche USGS Water-Data Report CO-84-2 (WRD/HD-85/244), 1985. 235p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Data collections, *Colorado, *Hydrologic data, *Surface water, *Water quality, *Groundwater, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for Colorado for the 1984 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. The report contains discharge records for 352 gaging stations, stage and contents of 23 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 32 crest-stage partial-record stations, and one miscellaneous site; water quality for 126 gaging stations and 275 miscellaneous sites; and water levels for 55 observation wells. Six pertinent stations in bordering States also were included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-04540 and W90-04542) (USGS)
W90-04541

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1984 VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
A. C. Duncan, R. C. Ugland, J. D. Bennett, and E. A. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-135308. Price codes: A16 in paper copy, A01 in microfiche USGS Water-Data Report CO-84-3 (WRD/HD-85/245), 1985. 240p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for Colorado for the 1984 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. The report contains discharge records for 352 gaging stations, stage and contents of 23 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 32 crest-stage partial record stations, and one miscellaneous site; water quality for 126 gaging stations and 275 miscellaneous sites; and water levels for 55 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-04540 thru W90-04541) (USGS)
W90-04542

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, A. C. Duncan, J. L. Ebling, and R. D. Steger.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-105979. Price codes: A16 in paper copy, A01 in microfiche USGS Water-Data Report CO-85-1 (WRD/HD-86/224), 1986. 353p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for Colorado for the 1985 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water discharge records for 351 gaging stations, stage and contents of 25 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and one miscellaneous site; water quality for 104 gaging stations and 256 miscellaneous sites; and water levels for 53 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-04540, W90-04544 and W90-04545) (USGS)
W90-04543

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985 VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, A. C. Duncan, J. L. Ebling, and R. G. Kretschman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-105987. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report CO-85-2 (WRD/HD-86/225), 1985. 239p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for Colorado for the 1985 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. The report contains discharge records for 351 gaging stations, stage and contents of 25 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and one miscellaneous site; water quality for 104 gaging stations and 256 miscellaneous sites; and water levels for 53 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-04543 and W90-04545) (USGS)
W90-04544

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1985. VOLUME 3. DOLORES RIVER BASIN, GREEN RIVER BASIN, AND SAN JUAN RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, A. C. Duncan, J. D. Bennett, and E. A. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-105995/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CO-85-3 (WRD/HD-86-226), 1986. 265p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for Colorado for the 1985 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. The report contains discharge records for 351 gaging stations, stage and contents of 25 lakes and reservoirs, 4 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and one miscellaneous sites; water quality for 104 gaging stations and 256 miscellaneous sites; and water levels for 53 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-04543 thru W90-04544) (USGS)
W90-04545

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1983.
Geological Survey, Hartford, CT. Water Resources Div.
C. E. Thomas, L. A. Weiss, I. S. Gasperini, and J. W. Bingham.
Available from the National Technical Information

Service, Springfield, VA 22161, as PB86-130499. Price codes: A19 in paper copy, A01 in microfiche USGS Water-Data Report CT-83-1 (WRD/HD-85/256), 1985. 300p. Prepared in cooperation with the State of Connecticut and other agencies.

Descriptors: *Connecticut, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Estuaries, Biological analysis.

Water-resources data for the 1983 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 47 gaging stations; storm discharge at 7 gaging stations; tidal volume at 1 gaging station; tidal stage at 4 gaging stations; contents at 35 lakes and reservoirs; water quality at 38 gaging stations, 4 lakes and reservoirs, 2 harbors, 3 precipitation stations, 6 partial-record stations, and 23 wells; and water levels at 32 observation wells. Also included are 41 crest-stage partial-record stations. Additional water data were collected at various sites involved in the systematic data-collection program and are published as miscellaneous measurements and analysis. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (USGS)
W90-04546

WATER RESOURCES DATA, CONNECTICUT, WATER YEAR 1984.
Geological Survey, Hartford, CT. Water Resources Div.
M. A. Cervione, T. B. Shepard, I. S. Gasperini, and J. W. Bingham.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-129375. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CT-84-1 (WRD/HD-86/259), 1986. 347p. Prepared in cooperation with the State of Connecticut and other agencies.

Descriptors: *Connecticut, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Estuaries.

Water-resources data for the 1984 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 46 gaging stations; storm discharge at 7 gaging stations; tidal volume at 1 gaging station; tidal stage at 4 gaging stations; contents at 35 lakes and reservoirs; water quality at 37 gaging stations, 4 lakes and reservoirs, 2 harbors, 3 precipitation stations, and 7 wells; and water levels at 35 observation wells. Also included are 41 crest-stage partial-record stations. Additional water data were collected at various sites involved in the systematic data collection program and are published as miscellaneous measurements and analysis. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (See also W90-04546) (USGS)
W90-04547

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1A: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-126455. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report FL-83-1A (WRD/HD-85/262), 1984. 289p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for northeast Florida include continuous or daily discharge for 92 streams, periodic discharge for 11 streams, miscellaneous discharge for 14 streams, peak discharge for 29 streams, continuous or daily stage for 28 streams; continuous elevations for 42 lakes and periodic elevations for 31 lakes; continuous groundwater levels for 32 wells, periodic groundwater levels for 144 wells, and miscellaneous water level measurements for 1,125 wells; quality of water for 35 surface water sites and for 210 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04549 thru W90-04553) (USGS)
W90-04548

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 1B: NORTHEAST FLORIDA.
Geological Survey, Tallahassee, FL.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-163714. Price codes: A10 in paper copy, A01 in microfiche SGS Water-Data Report FL-83-1B (WRD/HD-85/273), 1985. 196p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for northeast Florida include continuous or daily discharge for 92 streams, periodic discharge for 11 streams, miscellaneous discharge for 14 streams, peak discharge for 29 streams, continuous or daily stage for 28 streams; continuous elevations for 42 lakes and periodic elevations for 31 lakes; continuous groundwater levels for 32 wells, periodic groundwater levels for 144 wells, and miscellaneous water level measurements for 1,125 wells; quality of water for 35 surface water sites and for 210 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04548 and W90-04549 thru W90-04553) (USGS)
W90-04549

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
W. J. Haire, T. Miller, C. Price, and D. Hayes.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-163706. Price codes: A14 in paper copy, A01 in microfiche USGS Water-Data Report FL-83-2A (WRD/HD-86/203), 1985. 293p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Wells.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for South Florida include continuous or daily discharge for 73 streams, periodic discharge for 3 streams, continuous or daily stage for 74 streams, and periodic stage for 30 streams; continuous elevations for 13 lakes and periodic elevations for 5 lakes; continuous groundwater levels for 180 wells, periodic groundwater levels for 120 wells, and miscellaneous water level measurements for 336 wells; quality of water for 71 surface water sites and for 292 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04548 thru W90-04549 and W90-04551 thru W90-04553) (USGS)
W90-04550

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, W. L. Fletcher, and J. K. Ogle.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-216000. Price codes: A21 in paper copy, A01 in microfiche USGS Water-Data Report FL-83-3A (WRD/HD-85/211), 1985. 470p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Wells.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for southwest Florida include continuous or daily discharge for 74 streams, periodic discharge for 14 streams, miscellaneous discharge for 15 streams, peak discharge for 19 streams, continuous or daily stage for 18 streams; continuous elevations for 43 lakes and periodic elevations for 72 lakes; continuous groundwater levels for 223 wells, periodic groundwater levels for 141 wells, and miscellaneous water level measurements for 573 wells; quality of water for 120 surface water sites and 329 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in

Florida. (See W90-04548 thru W90-04550 and W90-04552 thru W90-04553) (USGS)
W90-04551

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1983 VOLUME 3B: SOUTHWEST FLORIDA - GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, W. L. Fletcher, and J. K. Ogle.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-216018. Price codes: A16 in paper copy, A01 in microfiche USGS Water-Data Report FL-83-3B (WRD/HD-85/212), 1985. 352p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Wells.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for southwest Florida include continuous or daily discharge for 74 streams, periodic discharge for 14 streams, miscellaneous discharge for 15 streams, peak discharge for 19 streams, continuous or daily stage for 18 streams; continuous elevations for 43 lakes and periodic elevations for 72 lakes; continuous groundwater levels for 223 wells, periodic groundwater levels for 141 wells, and miscellaneous water level measurements for 573 wells; quality of water for 120 surface water sites and 329 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04548 thru W90-04551 and W90-04553) (USGS)
W90-04552

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1983. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
J. B. Martin, P. E. Meadows, and P. R. Mixson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-135191. Price codes: A11 in paper copy, A01 in microfiche USGS Water-Data Report FL-83-4 (WRD/HD-85/267), 1985. 238p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Wells.

Water-resources data for the 1983 water year in Florida consist of continuous or daily discharge for 299 streams, periodic discharge for 29 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 76 streams, periodic stage for 47 streams, peak discharge for 86 streams and peak stage for 8 streams; continuous or daily elevations for 105 lakes, periodic elevations for 117 lakes; continuous groundwater levels for 472 wells, periodic groundwater levels for 610 wells, and miscellaneous water level measurements for 2,258 wells; quality of water data for 326 surface-water sites and 843 wells. The data for northwest Florida include continuous or daily discharge for 46 streams, periodic discharge for 7 streams, peak discharge for 19 streams, and continuous or daily stage for 4 streams, continuous elevations for 5 lakes and periodic elevations for 4 lakes; continuous groundwater levels for 25 wells, periodic groundwater levels for 87 wells, and miscellaneous water-level measurements for 70 wells; quality of water for 27 surface water sites and for 22 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-04548 thru W90-04552) (USGS)
W90-04553

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 1A: NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-197092. Price codes: A11 in paper copy, A01 in microfiche USGS Water-Data Report FL-84-1A (WRD/HD-86/221), 1986. 227p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface-water sites and 596 wells. The data for northeast Florida include continuous or daily discharge for 65 streams, periodic discharge for 7 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 37 streams, peak discharge for 15 streams and peak stage for 8 streams; continuous or daily elevations for 22 lakes, periodic elevations for 33 lakes; continuous groundwater levels for 31 wells, periodic groundwater levels for 90 wells, and miscellaneous water level measurements for 563 wells; quality of water data for 15 surface water sites and 45 wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-04548) (USGS)
W90-04554

8. ENGINEERING WORKS

8A. Structures

FLOODS FROM DAM FAILURES.
Cascades Volcano Observatory, Vancouver, WA.
For primary bibliographic entry see Field 2E.
W90-03687

REHABILITATION OF PEORIA LOCK USING PREPLACED-AGGREGATE CONCRETE.
Army Engineer District, Rock Island, IL.
For primary bibliographic entry see Field 8F.
W90-03757

RX FOR DAM REPAIR.
Bridgeport Hydraulic Co., CT.
For primary bibliographic entry see Field 8F.
W90-03974

STUDY OF AIR ENTRAINMENT: APPLICATION TO SPILLWAY DESIGN (ETUDE DES PHENOMENES D'ENTRAINEMENT D'AIR: APPLICATION AUX EVACUATEURS DE CRUE).
For primary bibliographic entry see Field 8B.
W90-04118

RIPRAP PROTECTION WITHOUT FILTER LAYERS.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulics Engineering.
A. Worman.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1615-1630, December 1989. 7 fig, 1 tab, 11 ref, append.

Descriptors: *Bridge construction, *Piers, *Riprap, *Flow velocity, *Open-channel flow, *Erosion, *Hydraulics.

Conventional multilayered riprap and filter protections around bridge piers can be substituted by one thick single layer of riprap. Because of this simpler construction, field installations are less likely to be defective. An analytical description was derived relating the mean flow velocity, which causes initiation of erosion of the base material, to characteristics of the single-layer protection and the base material. The governing dimensionless parameters describe suitable thickness of the riprap layer, grain size of riprap material, grain size of base material, and mean flow velocity. The diameter of the pier does not influence initiation of erosion. The theoretical expression was verified by means of comparative large-scale laboratory experiments. In most design conditions the simplified riprap protection requires a thinner protective layer than the conventional riprap and filter protection. (Author's abstract)
W90-04121

FIRST STAGE OF RIVER DIVERSION ACCOMPLISHED AT YACYRETA.
Harza y Consorciados, Ituzaingo (Argentina).
A. Lara, and N. Badano.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 27-31, December 1989. 7 fig.

Descriptors: *Hydraulic structures, *Argentina, *Paraguay, *River diversion, *Diversion structures, Design floods, Cofferdams, Dam design, Dam construction, Rockfill dams, Yacyreta Hydroelectric project, Foreign construction.

In June 1989, the final phase of the Parana river main branch diversion at the Yacyreta hydroelectric project in South America was completed, with a river discharge of 12,000 cu m/s (8400 cu m/s in the main branch) and a final diversion head of 2.3 mm. Because of the frequent major floods of the Parana river, the diversion process design flood was 30,000 cu m/s (21,000 cu m/s in the main branch), and a final diversion head of 6 m was considered. For that reason, with the relatively low discharges recorded during the diversion period, it was easily completed in a shorter time than anticipated. The selected method, combining the advantages of end dumping and crest levelling, optimized the use of resource (quarry rock with small dimensions and existing auxiliary bridge), and was effective in reducing the specific power (discharge times head) of the river at the closure section. Some 2,400,000 cu m of material was moved in 4 months, relating to the river diversion, including the removal and construction of cofferdams. The river discharges during this period varied between 11,000 and 15,000 cu m/s. The diversion of the other branch (Ana Cua) of the Parana River at Yacyreta is scheduled for June/July 1990. (Sand-PTT)
W90-04134

CHILE DEVELOPS MORE HYDROPOWER.
Empresa Nacional de Electricidad S.A., Santiago (Chile).
For primary bibliographic entry see Field 8C.
W90-04135

GEOLOGICAL PROBLEMS AT URUGUA-I RCC DAM.
Bechtel Corp., San Francisco, CA.
For primary bibliographic entry see Field 8E.

W90-04136

DESIGN AND CONSTRUCTION OF COLOMBIA'S GUAVIO DAM.
Ingetec S.A., Bogota (Colombia).
A. Marulanda, and F. Amaya.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 41-50, December 1989. 12 fig.

Descriptors: *Hydraulic structures, *Colombia, *Rockfill dams, *Dam design, *Dam construction, *Dam foundations, Guavio Dam, Hydroelectric power, Compressibility, Compaction, Grouting.

Colombia's Guavio dam, a rockfill structure with a central core, has been planned for a total capacity of 1600 MW. Construction started in 1981 and it is expected to generate energy with the first units by mid-1992. The height of the dam (245 m) and the differences in compressibility between the core material (if compacted at the natural water content) and the rockfill led to a conservative design to prevent cracking of the core. For this reason, the following aspects were considered: reduction of the natural water content of the core material before compaction to obtain a better compatibility with the rockfill material; design of a slightly inclined core that will act under compression as a result of the weight of the upstream shell; design of conservative double filters along the downstream boundary of the core; use of a wetter and more plastic material along the contact with the abutments and near the crest of the dam. The presence of a large scree deposit at the right abutment, from the riverbed to the top of the canyon, and evidence of karsticity led to the following measures: building of the upstream shell of the dam over the scree deposit; locating and inclining the core to found it over layers of sound quartzite and argillite with no evidence of karsticity; obtaining regular sound rock surfaces at the core foundation by removing weathered rock near the surface and pouring dental concrete where necessary; consolidating the rock in the area of the core and filters by surface grouting and designing a deep grout curtain; excavating galleries and shafts in the altered layers, where soils that are easily eroded and non-groutable were found; excavating several galleries downstream of the core foundation to investigate the rock conditions and to gain access for grouting works at several levels; protecting major joints or continuous altered layers exposed downstream of the core foundation, with filters. (Sand-PTT)
W90-04137

DIFFICULT FOUNDATIONS CHARACTERIZE THE CASA DE PIEDRA SCHEME.
Casa de Piedra Authority, Bahia Blanca (Argentina).
A. Etchehon, and J. F. Speziale.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 51-55, December 1989.

Descriptors: *Hydraulic structures, *Geology, *Dam design, *Argentina, *Dam construction, *Dam foundations, Casa de Piedra Project, Dam stability, Sedimentary rocks, Tunneling.

The Casa de Piedra multipurpose hydro development, now at the impounding stage, is in the central plains of Argentina at the northern boundary of the Patagonian desert, some 500 km inland from the Atlantic Ocean. It has involved the construction of a 10.8 km-long dam on the Colorado River. The project has been characterized by the hostile nature of the heterogeneous foundation conditions on weak strata, composed of sedimentary rocks (formed mostly by chemical deposition in late Mesozoic and early Cenozoic seas) and shallow littoral areas. This led to geotechnical problems of a very specific nature, regarding the foundation and tunnelling conditions, which had to be solved during construction. Various combinations of plastic cement facing, shotcreting, anchoring, and drains were applied. (Author's abstract)
W90-04138

SOME EXPERIENCES WITH HEAD LOSSES IN LINED TUNNELS IN PERU.
Deutsche Gesellschaft fuer Technische Zusammenarbeit m.b.H., Eschborn (Germany, F.R.).
J. J. Victoria.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 56-60, December 1989. 3 fig, 2 tab, 3 ref.

Descriptors: *Hydraulic structures, *Head loss, *Peru, *Tunnel linings, *Hydroelectric plants, *Tunnel construction, Penstocks, Roughness coefficient, Operating policies, Discharge measurement.

To improve operation policies of the interconnected system of Peru and also to study the possibility of increasing the installed capacity, measurements of head losses and discharges in power tunnels and penstocks have been carried out at Peru's two largest hydroelectric power stations. The power tunnels are concrete lined and were constructed using modern techniques, including steel formworks to obtain smooth surfaces. Among the most relevant results of the measurements was the fact that both power tunnels showed very similar roughness coefficients, around 64 in the Manning-Strickler formula. This value is lower than normally recommended in the literature for these conditions. (Author's abstract)
W90-04139

FLOOD DAMAGE ANALYSIS--GRANDVIEW HEIGHTS CASE STUDY.
Corps of Engineers, Huntington, WV. Huntington District.
For primary bibliographic entry see Field 6F.
W90-04238

ANALYSIS OF TRAINING STRUCTURE DESIGNS IN SOUTHWEST PASS, MISSISSIPPI RIVER.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. B. Heltzel, W. D. Martin, R. C. Berger, and D. R. Richards.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-89-22, November 1989. Final Report. 47p, 12 fig, 3 tab, 5 ref, append.

Descriptors: *Flood control, *Hydraulic structures, *Mississippi River, *Navigation channels, Dikes, Channels, Mathematical models, Sediment transport, Sedimentation, Jetties.

The Southwest Pass of the Mississippi River is the main navigation outlet to the Gulf of Mexico. As a part of planned efforts to stabilize the banks of the Southwest Pass and reduce maintenance dredging, improvements on the lower part of the river near the entrance were being reviewed due to the significant costs of this portion, in particular, the concrete pile inner bulkhead in the jetty reach. This report details an investigation which had as its primary objective to produce an alternative design which is lower in construction costs and provides comparable reduction of channel sedimentation relative to the inter bulkhead plan. This objective was undertaken by consideration of plans which modify the existing dike fields along the Southwest Pass channel. Seven plans and existing conditions were evaluated using the TABS-2 finite element numerical model RMA-2V to provide the flow fields and the Memphis District method and Colby's method for sediment transport capacities. The plan dike fields were developed as a logical progression by consideration of the uniformity of the longitudinal channel velocity and sediment transport capacity. Results indicate that the important element is the extension of the dike fields back to the jetty to prevent flow out of the channel and behind the dikes. The plan which involves the extension of only six existing dikes, provides nearly the same velocity profile and transport capacity as the inner bulkhead design at a fraction of the construction costs--this plan is the recommended design. (Author's abstract)
W90-04251

ARTIFICIAL INTELLIGENCE APPLICATIONS IN ENGINEERING DESIGN: RESEARCH AT M.I.T.
Massachusetts Inst. of Tech., Cambridge.
D. Navinchandra, D. Serrano, N. Groleau, D. Sriram, and R. Logcher.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 175-195, 9 fig, 6 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Engineering, *Computers, *Design criteria, *Artificial intelligence, Automation.

Advances in computer hardware, software and engineering methodologies have led to an increased use of computers by engineers. In design, this use has been limited almost exclusively to algorithmic solutions such as the finite element method, and circuit simulators. However, a number of problems encountered in design are not amenable to purely algorithmic solutions. These problems are often ill-structured in that the problems do not have a clearly defined algorithmic solution. Engineers deal with them using judgment and experience. Artificial intelligence techniques offer a methodology to solve these ill-structured design problems. Four research projects that use artificial intelligence for design automation include CYCLOPS (Criteria Yielding, Consistent Labeling Optimization and Precedents-based System)-generated innovative designs using a three stage process: normal search. exploration and adaptation; ALLRISE synthesized designs using top-down refinement and constraint propagation techniques; a constraint management system, performing the evaluation and consistency maintenance of constraints arising in design; and CIDCIS, facilitating coordination, communication and control during the entire design and construction phases. (See also W90-04274) (Author's abstract)
W90-04287

CAD IN THE DESIGN OF PIPELINES FOR IRRIGATION SCHEMES.
Lotti (C.) and Associates, Rome (Italy).
M. G. D'Amico, and A. Gabos.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 233-237.

Descriptors: *Computer-aided design, *Irrigation engineering, *Computer programs, *Computer-aided engineering, *Engineering, *Computers, *Design criteria, Ecuador, Reservoirs, Construction costs.

Procedures were developed for using a computer to design piped irrigation schemes. The objective is to provide the design engineer with a tool that permits a rapid assessment of the design choices through the display and printing of the design parameters and costs. The speed of processing and the flexibility of the procedures make it possible to study alternative solutions, so that the best technical and economic solution is found. Consequently, there is a substantial reduction of design costs and greater accuracy in the choices that the engineer has to make. Draftsmen can be eliminated because the final drawings can be obtained automatically with the tabulations and cost of materials needed. This method was successfully used in a piped irrigation project in Pillaro, Ecuador. The project provided irrigation for an area of 8,000 ha, with the installation of more than 600 km of pipes and the construction of 21 compensation reservoirs. (See also W90-04274) (Hammond-PTT)
W90-04291

REPRO: HYDRAULIC NETWORK DESIGN.
Lotti (C.) and Associates, Rome (Italy).
A. Gabos, and M. G. D'Amico.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 239-243.

Descriptors: *Computer programs, *Computer-aided engineering, *Computer-aided design, *Computers, *Mathematical analysis, *Water conveyance, Water supply, Hydraulics, Pipelines, Conveyance structures.

A computer program for closed loop water supply network design can be used for both the construction of new networks and the extension of existing networks. The computation was made using only the pipe diameters specified by the user. This avoided the need to make the theoretically optimal diameters approximate to the nearest real diameter. The optimization process has two phases:(1) the search for a feasible solution; and (2) the search for the optimal solution. An original, heuristic search method was applied which ensured fast computation and a close to optimal solution. This solution satisfies up to three different demand conditions simultaneously (e.g., peak hour consumption and two different locations of fire hydrants). The output contains a detailed description of the solution and a summary of pipes according to classes and descriptions. (See also W90-04274) (Hammond-PTT)
W90-04292

FLUID-STRUCTURE INTERACTION: EXPERIMENTAL AND NUMERICAL ANALYSES.
Centro Informazioni Studi Esperienze, Milan (Italy).
For primary bibliographic entry see Field 8B.
W90-04307

CULVERT DESIGN AND CHANNEL EROSION.
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
H. R. Malcom.
IN: Water Problems of Urbanizing Areas. Proceedings of the Research Conference, New England College, Henniker, New Hampshire, July 16-21, 1978. The American Society of Civil Engineers, New York. 1979. p 298-305, 3 fig.

Descriptors: *Urban hydrology, *Water pollution control, *Culverts, *Channel erosion, *Erosion control, *Flood control, *Hydraulic design, *Urbanization, Channel flow, Suspended solids, Backwater effect, Drainage, Land use, Design standards, Erosion, Flood peak, Urban runoff, Highway effects.

Conventionally developed urban watersheds include significant temporary storage which typically has been concentrated behind culverts and bridges. The location and the magnitude of storage in relation to the size of the watershed are important determinants of the degree of peak flow reduction. Large facilities on the mainstem have a greater effect on the peak than small facilities distributed widely through the watershed. The primary hydraulic consideration in culvert design is to pass flood discharges with minimum backwater effect; but, on urban streams of considerable slope, channel erosion also must be considered. Channel erosion is continuous throughout geologic time, affecting all but alluvial streams; but the process of urbanization accentuates it because of the increase in peak storm water discharges and increases in total quantity of runoff. Research is underway to quantify these urbanization/erosion relationships. There is a definite tendency for greater erosion in streams with a greater proportion of more intensive land uses, and high proportions of artificial drainage. When culverts restrict flow and create backwater conditions upstream of roadways, the ponding water behaves as a settling basin in which the suspended particles are removed from the runoff. As the water passes through the culvert, its load of solids has been reduced, or equivalently its carrying capacity for additional channel erosion has been enhanced. Backwater effects could be reduced without increasing culvert velocities by using the 'imporved inlet design,' which has been accepted by the Federal Highway Administration. (See also W90-04338)(Lantz-PTT)
W90-04368

CONFIGURATION AND SUBSTRATE DESIGN CONSIDERATIONS FOR CONSTRUCTED WETLANDS WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04423

CONSTRUCTING THE WASTEWATER TREATMENT WETLAND: SOME FACTORS TO CONSIDER.
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 5D.
W90-04426

CONSTRUCTED WETLANDS: DESIGN, CONSTRUCTION AND COSTS.
Dames and Moore, Boston, MA.
For primary bibliographic entry see Field 5D.
W90-04448

DESIGN AND CONSTRUCTION OF A RESEARCH SITE FOR PASSIVE MINE DRAINAGE TREATMENT IN IDAHO SPRINGS, COLORADO.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 5D.
W90-04469

EARTH DAMS: DESIGN, CONSTRUCTION, AND SAFETY. JANUARY 1977-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, Va. 22161, as PB89-855126. Price codes: NO1 in paper copy, NO1 in microfiche. February 1989. 167 p. Supersedes PB86-874047.

Descriptors: *Bibliographies, *Dam design, *Dam construction, *Earth dams, *Dam failure, Dam stability, Mathematical models, Seepage, Construction materials, Stress, Literature review.

This bibliography contains 290 citations concerning design, construction methods, and failure of earth dams. Stability, seepage, creep, construction materials, and performance evaluations are considered. Mathematical models for determining stress are included, as well as examination and evaluation of existing foreign and domestic dams. Sixty-seven citations are new entries to the previous edition. (Author's abstract)
W90-04482

8B. Hydraulics

EXTENDING STREAM RECORDS WITH SLACKWATER PALEOFLOOD HYDROLOGY: EXAMPLES FROM WEST TEXAS.
Southern Illinois Univ. at Carbondale. Dept. of Geology.
For primary bibliographic entry see Field 2E.
W90-03683

ISCO OPEN CHANNEL FLOW MEASUREMENT HANDBOOK.
Isco, Inc., Lincoln, NE. Environmental Div.
For primary bibliographic entry see Field 7B.
W90-03749

PAST DEVELOPMENTS IN PIPE DRAINAGE AND ITS FUTURE PROSPECTS.
For primary bibliographic entry see Field 3F.
W90-03807

WINYAH BAY, GEORGETOWN, SOUTH CAROLINA, DATA COLLECTION SURVEY REPORT.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2L.
W90-03819

HIGH-RESOLUTION TWO DIMENSIONAL ADVECTIVE TRANSPORT.
Geological Survey, Sacramento, CA. Water Resources Div.
P. E. Smith, and B. E. Larock.
IN: Hydraulic Engineering '89 Proceedings, National Conference on Hydraulic Engineering, HY Div, ASCE, New Orleans, Louisiana, August 14-18, 1989. 1989. p 1005-1010, 2 fig, 10 ref.

Descriptors: *Hydraulics, *Flow, *Advection, *Mathematical models, *Computer models, *Model studies, *Hydrodynamics, Mathematical studies.

One of the most troubling problems in computational hydraulics is numerical treatment of advective terms, which appear in the conservation laws governing momentum and scalar transport and often are the source of errors in numerical solutions. Most conventional high order finite difference approximations for advective terms, such as the Lax-Wendroff and leapfrog schemes, work well if a solution is smooth, but generate dispersive oscillations when solution gradients are steep relative to numerical grid size. Low order approximations, such as the upwind method, can be used to prevent oscillations, but only at the cost of introducing too much numerical diffusion. A 2-dimensional high resolution scheme for advective transport was developed based on a Eulerian-Lagrangian method with a flux limiter. The scheme was applied to the problem of pure advection of a rotated Gaussian hill and shown to preserve the monotonicity property of the governing conservation law. (Lantz-PTT)
W90-03827

STUDY OF AIR ENTRAINMENT: APPLICATION TO SPILLWAY DESIGN (ETUDE DES PHENOMENES D'ENTRAINEMENT D'AIR: APPLICATION AUX EVACUATEURS DE CRUE).
H. Chanson.
Houille Blanche HOBLAB, Vol. 1989, No. 6, p 443-462, 1989. 31 fig, 5 tab, 22 ref.

Descriptors: *Dam design, *Spillways, *Cavitation, *Erosion control, *Air entrainment, *Aeration, *Aerators, *Hydraulic engineering, Shear stress.

Cavitation erosion damage to spillway surfaces may be prevented by using aerators. These serve to introduce air in the layers close to the channel bottom in order to reduce the cavitation damage. The performances of spillway aerators were studied with data obtained on a steep spillway model and high velocities (from 4 m/s up to 15 m/s). Refinements were made on previously developed mathematical equations to derive the speed, distribution, and concentration of air entrainment. Air concentration and velocity profiles at various cross-sections above and downstream of the aerator in conjunction with these equations provided a better understanding of the air entrainment process above a bottom aerator. This analysis of the flow downstream of an aerator enables the determination of aerator spacing more accurately. (Author's abstract)
W90-04118

HYDRAULIC JUMP AS 'MIXING LAYER'.
San Diego State Univ., CA. Dept. of Mechanical Engineering.
J. W. Hoyt, and R. H. J. Sellin.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1607-1614, December 1989. 9 fig, 13 ref.

Descriptors: *Hydraulic jump, *Flow characteristics, *Turbulent flow, *Fluid mechanics.

In free-surface water flows the hydraulic jump has usually been considered a turbulent reverse roller supported by an underlying and expanding stream.

The air-entrainment aspect of the water surface at the jump is normally a predominant feature. In this investigation the character of the turbulence in the jump, and therefore of the air-entrainment mechanism, is controlled by the use of drag-reducing soluble additives. The resulting lower level of entrained air permits photographic and visual observation of a jump in a small glass-sided laboratory flume. The photographs show that the remaining air bubbles act as flow tracers and reveal a turbulent structure in the upper part of the jump very similar in appearance to that observed for a turbulent mixing layer in a wind tunnel using shadow refractography. Measurements of expansion angles for the turbulence structures in the jump agree well with wind-tunnel measurements of expansion angles for the turbulent mixing layer between coflowing airstreams with a velocity difference. (Author's abstract)
W90-04120

RIPRAP PROTECTION WITHOUT FILTER LAYERS.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Hydraulics Engineering.
For primary bibliographic entry see Field 8A.
W90-04121

SIMULATING EFFECT OF CHANNEL CHANGES ON STREAM INFILTRATION.
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 2E.
W90-04122

VOLUMETRIC APPROACH TO MULTIAQUIFER AND HORIZONTAL FRACTURE WELLS.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
Z. Sen.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1646-1666, December 1989. 10 fig, 23 ref.

Descriptors: *Aquifer testing, *Groundwater movement, *Type curves, *Multiaquifer wells, *Aquifers, *Volumetric analysis, *Well hydraulics.

A set of type curves has been derived for aquifer test analysis in horizontally fractured rock environments by using the volumetric approach. The validity of this approach has been confirmed with the numerical as well as analytical results in the literature concerning the multiaquifer wells that are similar to multihorizontal fracture wells. In the general formulation, each fracture is assumed to have different aperture and roughness. Various simplifications of the formulation are given to cover some theoretical as well as practical interests. The volumetric method relates especially the fracture aperture and roughness to other hydraulic quantities through the type curve expressions. The well storage effect has been taken into consideration and as a result the initial portions of type curves appear as straight lines on the double logarithmic paper that implies power law relation. The final portions of type curves are also straight lines, but on semilogarithmic paper, implying an exponential type of relation. The practical applications of the developed methodology has been presented for the time-drawdown data obtained from the main well that is in horizontally fractured rock aquifer at Halifax County, Nova Scotia, Canada.(Author's abstract)
W90-04123

RADIAL FLOW IN VERTICALLY GRADED HYDRAULIC CONDUCTIVITY AQUIFERS.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology.
For primary bibliographic entry see Field 2F.
W90-04124

VISCOUS DAMPING: TIME CONVOLUTION OF IMPULSIVE SOLUTION.
Istituto Univ. Navale, Naples (Italy).
E. P. Carratelli.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1683-1693, December 1989. 6 fig, 12 ref.

Descriptors: *Flow around objects, *Flow characteristics, *Laminar flow, *Viscosity, *Viscous flow, *Hydrodynamics, *Fluid mechanics, Mathematical equations.

A method is proposed to calculate the interaction between an oscillating body and the water surrounding it for low values of the Keulegan-Carpenter number and in laminar flow conditions. Rather than dividing the viscous forces originated by the unsteady motion into an added mass inertia force and a frictional, energy dissipating, component, the interaction is evaluated through a 'Basset term' style convolution integral of the expression of the force calculated for impulsively started flow. A numerical procedure is employed to show that, for simple motions, the method proposed yields solutions similar to those obtainable by the classical approach, while it can efficiently deal with the problems involving complex forcing actions or very short impulses, where the traditional approach fails to provide satisfactory results. The applicability of this technique is limited to purely laminar flows, thus including most of the problems relating to the hydrodynamic damping of vibrating structures and excluding the whole domain of wave induced forces. (Author's abstract)
W90-04125

ANALYTIC SOLUTIONS FOR TIDAL MODEL TESTING.
Systech Engineering, Inc., Lafayette, CA.
C. L. Chen.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1707-1714, December 1989. 6 fig, 2 ref.

Descriptors: *Flow models, *Tidal hydraulics, *Hydrodynamics, *Shallow water, *Model studies, *Bathymetry, *Error analysis, Mathematical equations.

Any hydrodynamics model should be verified by comparing its results both with analytic solutions and field measurements to establish the validity of the model as a proper system simulator. The analytic solutions can only be obtained for simplified equations and boundary conditions. Previous analytic solutions for computer flow model testing were analyzed. They involved detailed analytic solutions of the linearized shallow water equations including bottom friction, wind stress, and variable bathymetry in Cartesian and polar geometry. However the solutions for cases of reverse quadratic bathymetry in both Cartesian and polar geometry should be corrected. Among the Bessel functions y(sub p) is a linear combination of J(sub p) and J(sub -p). If p is not zero, or a positive integer,, using Y(sub p) or J(sub -p) gives the same answers as for zeta and v. With the above corrections, a set of test cases for evaluating the performance of tidal models is reformed. (Sand-PTT)
W90-04128

EQUATIONS FOR AXISYMMETRIC AND TWO-DIMENSIONAL TURBULENT JETS.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
W. C. Mih.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 115, No. 12, p 1715-1719, December 1989. 2 fig, 12 ref.

Descriptors: *Turbulent flow, *Hydraulics, *Mathematical equations, Turbulent jets, Shear stress.

Hydraulic engineering information on turbulent jets developed since 1948 are evaluated. Closed-form equations are derived for radial velocities and Reynolds shear stresses in the fully developed region of axisymmetric (circular) and two-dimensional (planar) jets. For both circular and planar jets, the mean axial velocity in the fully developed region has been proven experimentally to fit the Gaussian normal distribution. Turbulent shear stresses based on the closed form equations agree fairly well with experimental measurements. The mean radial velocity in a circular jet is zero at r/x = 0.115. If the discharging jet has a different color than the ambient fluid, the visible color demarcation should occur at this point. For a planar jet, v = 0 occurs at y/x = 0.131. (Sand-PTT)
W90-04129

EXPERIMENTAL RESEARCH ON PERMEABILITY OF GRANULAR MEDIA.
Shaanxi Inst. of Mechanical Engineering, Xian (China). School of Water Resources and Hydroelectric Engineering.
For primary bibliographic entry see Field 2F.
W90-04163

COMPUTER METHODS AND WATER RESOURCES: FIRST INTERNATIONAL CONFERENCE, MOROCCO 1988.
Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. 458p. Edited by D. Ouazar and C.A. Brebbia.

Descriptors: *Hydraulic engineering, *Computer programs, *Computer-aided engineering, *Engineering, *Mathematical studies, *Computers, *Data acquisition, *Hydraulics, Artificial intelligence.

The fourth volume of the conference on computer methods and water resources contains papers related to computer-aided engineering in water resources. The papers are divided into four sections as follows: numerical aspects and computational methods; advances in computer hardware related to data acquisition; advances in software such as expert systems and artificial intelligence; and fluid-structure interaction, including the analysis of offshore structures. (See also W90-04275 thru W90-04307) (Hammond-PTT)
W90-04274

SPECTRAL ANALYSIS IN COMPUTATIONAL FLUID MECHANICS: DEVELOPMENT OF A NUMERICAL APPROACH.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
A. Giorgini.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 3-31, 10 fig, 42 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Fluid mechanics, *Hydrodynamics, *Fourier analysis, *Computers, *Mathematical analysis, Simulation analysis, Algorithms, Vortices, Lake breezes, Wind.

The Fourier series approach to the solution of nonlinear equations such as the Burgers equation and the Navier-Stokes equations has been very useful. Numerical experiments on the Burgers equation had been performed using 200 modes. Spectral analysis has been used to demonstrate that the unusual behavior of the Fourier Space was not due to the dynamics of numerical instabilities and the resulting numerical methods have been used in simulating hydrodynamic problems. Other important advances include the computer application of the Fast Fourier Transform, the development of the Short Convolution algorithm, and the refinement of the Direct Transversal integration. All of these discoveries have been used to investigate problems in fluid mechanics such as 2-dimensional turbulence; the vortex wake behind a circular cylinder; the use of logpolar coordinates; the vortex wake behind an elliptic cylinder using elliptical coordinates; the use of cylindrical coordinates to study Taylor vortex flow; and the application of vertically averaged generated fluid motion equations to wind generated circulation in general shape lakes. (See also W90-04274) (Hammond-PTT)
W90-04275

TREATMENT OF BODY FORCE INTEGRALS IN BOUNDARY ELEMENTS.
Computational Mechanics Inst., Southampton (England).
C. A. Brebbia, and W. Tang.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 33-43, 13 ref.

Descriptors: *Hydraulics, *Computer programs, *Computer-aided engineering, *Fourier analysis, *Mathematical studies, *Computers, Data processing, Boundary element methods.

One of the main problems in the development of boundary element methods has been how to treat body force integrals efficiently. These integrals may be produced by forces distributed throughout the domain, non-linear effects, initial conditions in time-dependent problems, etc. Cell integration is a relatively simple technique and is used widely for the solution of many boundary element problems, particularly those involving non-linearities or time-independent terms. It is particularly useful when it is applied in conjunction with a suitable integration scheme. The major drawback is that the domain needs to be discretized into cells. The Galerkin function approach can only be used in cases for which this function is known. For complex non-linear or time-dependent problems this approach is not suitable. A more versatile approach is the use of expressions to represent the body forces and in this manner to propose particular solutions of a more general type. The Fourier Series expansion produces accurate and convergent results. In this method, the Fourier coefficients must be calculated first. When this is done numerically, the technique requires more time of the central processing unit and gives less accurate results. The Dual Reciprocity Method has been shown to be a powerful tool in many time-dependent problems, but suffers from the disadvantage that it may not give convergent results in other applications. (See also W90-04274) (Hammond-PTT)
W90-04276

SPECTRAL FINITE ANALYTICAL NUMERICAL METHOD FOR THREE-DIMENSIONAL UNSTEADY NAVIER-STOKES EQUATIONS.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
A. Hamidi, and A. Giorgini.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 57-66, 14 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Flow equations, *Hydraulics, *Unsteady flow, *Mathematical models, *Navier-Stokes equations, Algorithms, Fourier analysis, Boundary element methods, Differential equations, Vortices.

A mathematical model for 3-dimensional unsteady flows has been derived from the Navier-Stokes equations in their Fourier space form. This form is composed of two vorticity transport equations, containing convolution terms that can be approached by the Fast Fourier Transform algorithm, and two pseudo stream function equations that are two ordinary differential equations in Fourier space. The model is based on the integration of these differential equations, yields an analytical formulation of the radial dependency of the pseudo stream function coefficients. Thus, while the vortices can be advanced in time according to a suitable numerical scheme, the pseudo streamfunctions and their derivatives can be obtained at each time step by using these analytical formulations. Additionally, boundary values of the vorticity coefficients are obtained from integral formulations along with values of the pseudo streamfunction coefficients at the boundaries. (See also W90-04274) (Author's abstract)
W90-04278

IMPLICIT NUMERICAL MODELING OF UNSTEADY FLOW IN THE TIGRIS-DIYALAH CONFLUENCE.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
S. M. Abdul-Salam.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 83-95, 9 fig, 8 ref.

Descriptors: *Model studies, *Unsteady flow, *Hydraulics, *Computer programs, *Computer-aided engineering, *Mathematical models, *Tigris river, *Diyalah river, *Hydrodynamics, *Flow, Flood flow, Simulation analysis, St Venant equation.

Gradually varied unsteady flow in natural channels may be simulated by a model based on the St. Venant equations. A one dimensional formulation of these equations is presented for simulating the flow in a single reach or a confluence of two reaches, using the four-point implicit finite difference formulation. The model solves the nonlinear equations using the Newton-Raphson iteration method and a modified Gaussian elimination technique. Model calibration for the Tigris River and its confluence with the Diyalah River was achieved using data from the 1977 early spring flood. Verification of the model was obtained by using it to predict the hydraulics of a later flood in the same network. Model runs and comparison of its results with actual field data indicate the feasibility of such techniques and the accuracy of results. (See also W90-04274) (Author's abstract)
W90-04280

APPLICATION OF THE BOUNDARY ELEMENT METHOD TO SOME ELLIPTIC FLUID MECHANICS PROBLEMS.
Delaware Univ., Newark. Dept. of Civil Engineering.
S.T. Grilli.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 97-113, 7 fig, 1 tab, 15 ref.

Descriptors: *Model studies, *Computer programs, *Computer-aided engineering, *Hydraulics, *Fluid mechanics, *Mathematical models, *Boundary element methods, Flow, Waves.

The Boundary Element Method (BEM) is one of the most powerful numerical tools developed by engineers for studying fluid mechanics. The BEM was applied to elliptic or Laplace problems, linear sea wave modeling, 2-dimensional steady state porous media flow, and dynamic interactions of fluids and structures. In each case, the problem's particular features are outlined and the advantages of using the BEM are demonstrated. For the same level of accuracy, the BEM is faster than domain discretization techniques, such as the finite element method. To obtain acceptable results, it is necessary to develop elaborate techniques for both the discretization and the numerical integration of the BEM boundary integral equations. (See also W90-04274) (Hammond-PTT)
W90-04281

CLASSICAL METHODS AND PARAMETERS OF SPECTRAL ANALYSIS. DESCRIPTION AND IMPLEMENTATION(METHODES CLASSIQUES ET PARAMETRIQUES D'ANALYSE SPECTRALE. DESCRIPTION ET MISE EN OEUVRE).
Centre Univ. de Luminy, Marseille (France). Inst. de Mecanique Statistique de la Turbulence.
M. Bourguel, and B. Chapron.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 115-127, 4 fig, 9 ref. No English summary.

Descriptors: *Computer programs, *Computer-aided engineering, *Spectral analysis, *Unsteady flow, *Hydraulics, *Waves, *Mathematical studies, Fourier analysis, Boundary element methods.

Various classical methods, based on the Fourier equation, are reviewed with respect to their use in the spectral analysis of a field of stationary and non-stationary waves. Methods reviewed include parametric spectral analysis; the autoregressive method (both linear and with variable coefficients); the Prony model; the Pizarenko model, and the differential spectral analysis method. Because of its flexibility and ease of calculation, the differential spectral analysis method was selected as being particularly well adapted to analyzing data from sampling runs of short duration. (See also W90-04274) (Peters-PTT)
W90-04282

USE OF A MIXED SPECTRAL-FINITE ANALYTIC NUMERICAL TECHNIQUE FOR THE ANALYSIS OF THE VORTEX SHEDDING PAST A CIRCULAR CYLINDER.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
G. Alfonsi, and A. Giorgini.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 129-140, 6 fig, 7 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Mathematical studies, *Computers, *Flow around objects, *Vortices, *Hydraulics, *Simulation analysis, Navier-Stokes equations, Flow.

The flow of a viscous fluid past an impulsively started circular cylinder at Re=1000, has been simulated by integrating the time dependent Navier-Stokes equations using a mixed spectral-finite analytic numerical technique. In order to simulated the vortex shedding process, a perturbation, consisting of a pure rotational field, has been imposed on the initially nonrotational flow at time T=0; the mathematical formulation of the perturbation is characterized by two quantities, the strength and the spread, both depending on the values of two parameters, C and n. The results presented correspond to the values c=1.6 and n=10. Computer generated drawings depict the flow fields, in terms of absolute streamlines and vorticity. The sequence of the genesis and detachment of the primary vortices appears clearly as well as the evolution of the whole process in time. (See also W90-04274) (Author's abstract)
W90-04283

BOUNDARY ELEMENT APPROACH TO ONE-DIMENSIONAL WAVE EQUATION.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco). Hydraulic Dept.
B. Benmansour, D. Ouazar, and C. A. Brebbia.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 141-152, 7 fig, 1 tab, 10 ref.

Descriptors: *Model studies, *Computer programs, *Computer-aided engineering, *Boundary element methods, *Wave propagation, *Hydraulics, *Mathematical models, Simulation analysis.

The Boundary Element Method was developed for a one dimensional wave equation with non-homogeneous boundary conditions, preserving the hyperbolic characteristics of the initial problem. The timed-dependent fundamental solution was used instead of time-stepping techniques. Constant and linear shape functions were used in space and time. Two numerical experiments were carried out to establish the accuracy and the reliability of the Boundary Element Method for solving hyberbolic problems. The first example deals with the linearized, vertically averaged equations for long wave propagation with convective and frictional terms neglected. The second example represents a vibrating string with fixed ends. At initial time T=0, the displacement was equal to h in the middle of the

string and varied linearly towards the fixed ends. In contrast to other classical methods, two optimum values of beta were found. Beta = 1 was the most economical one. (See also W90-04274) (Hammond-PTT)
W90-04284

APPLICATIONS OF THE METHOD OF FUNDAMENTAL SOLUTIONS IN WATER RESOURCES.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
D. Ouazar.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 153-162, 3 fig, 12 ref.

Descriptors: *Model studies, *Computer programs, *Computer-aided engineering, *Mathematical models, *Computers, *Flow equations, *Hydraulics, *Boundary element methods, Differential equations, Dams, Seepage.

A Boundary Element-like technique was developed that uses the fundamental solution of the governing partial differential operator and has a discrete distribution of a finite number of singularities outside the involved domain. Assuming some distribution mode of singularities outside the domain, the problem can be linearized and greatly simplified. Once the unknown coefficients are determined, the solution and its derivatives can be computed by a simple expansion series. The seepage flow through a earthen dam sitting on an impermeable foundation is used to illustrate the application of the method to free surface location problems. (See also W90-04274) (Hammond-PTT)
W90-04285

SHARING OF SIMULATION TOOLS AND TRANSFER OF TECHNOLOGY.
Centre de Formation, de Recherche et d'Essais Hydrauliques de Grenoble (France).
P. Belleudy, M. Erlich, and P. Sauvaget.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 259-266, 5 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Mathematical models, *Simulation analysis, *Computers, *Technology transfer, *Hydraulics, *Forecasting, Niger River, Computer programs, Developing countries.

Sharing of hydraulic simulation tools as a part of the integrated process of technology transfer is described. The traditional customer/manufacturer relations have evolved towards a partnership in the joint development of software dedicated to numerical modeling of complicated hydraulic phenomena. The practical application of those principles during the development and training phases of the construction of a real-time forecasting system for the Niger River discharges is discussed. The practical application was essential for testing the program prototype and for discovering the software problems. The operating staff from 10 African countries participating in the Hydroniger Project were trained in the final phases of the software development schedule. Their remarks were helpful in preparing the final version of the computerized forecasting system to be implemented on the Hydroniger mainframe computer. (See also W90-04274) (Hammond-PTT)
W90-04294

COMPUTER AIDED DESIGN SOFTWARE IN FLUVIAL HYDRAULICS: PROGRAM CADRIV.
Universite Catholique de Louvain, Louvain-la-Neuve (Belgium). Dept. of Civil Engineering.
Y. Zech, G. Bertrand, and B. Vandestrick-Huberlant.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 267-275, 6 fig.

Descriptors: *Open-channel flow, *Streamflow, *Computer programs, *Computer-aided engineering, *Hydraulics, *Computers, *Engineering, *Computer-aided design, Data processing, Mathematical analysis, Computer programs, Developing countries.

The CADRIV program has been developed for the hydraulic engineer involved in fluvial hydraulics. The use of the program is interactive, designed to follow a logical sequence of questions and answers in fluvial hydraulic problems. The program provides graphical representation, a table of useful geometric or hydraulic parameters, data verification or modification, and water-profile computation. In the case of missing data, in developing countries or elsewhere, the programs helps to complete the data set. The CADRIV program contains 2500 statements. All of the applications are included, but the interaction among the calculation steps is decided by the user. For example, all the data for determining the location and the amplitude of a jump are given, but the user decides if the jump actually exists, avoiding hydraulically senseless solutions. (See also W90-04274) (Hammond-PTT)
W90-04295

SIMPLE NUMERICAL MODELS FOR COASTAL POWER PLANTS PROJECTS.
Laboratoire National d'Hydraulique, Chatou (France).
M. Darras, and B. Latteux.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 277-290, 7 fig, 8 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Model studies, *Mathematical models, *Computers, *Design criteria, *Simulation analysis, *Powerplants, *Coastal engineering, Wave propagation, Thermal pollution.

Siting a power plant on the coast requires various studies in hydraulics connected mainly with the design of the intake and outlet structures and with their effect on the marine environment. Many of these studies can use simple numerical models. These models are related to the evaluation of design wave and design water levels; the propagation of waves from offshore to the coast; the wave agitation inside the intake works; and the thermal impact in the near field and in the far field. The models are easy to use and can be run on small computers. They are particularly well suited for parametric studies and sensitivity analyses, which are useful in estimating the effect of uncertainties concerning field data. (See also W90-04274) (Hammond-PTT)
W90-04296

COMPUTER AIDED OPERATION OF IRRIGATION SYSTEMS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 3F.
W90-04297

MEASUREMENT AND ANALYSIS OF DYNAMIC PRESSURES ON HYDRAULIC MODELS.
Technische Univ., Graz (Austria). Inst. for Hydromechanics, Hydraulics and Hydrology.
P. Klasinc.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 305-316, 8 fig, 5 ref.

Descriptors: *Hydraulic models, *Computer programs, *Computer-aided engineering, *Mathematical models, *Data acquisition, *Hydraulics, Flow, Hydraulic gates, Pressure distribution, Pressure-measuring instruments, Fourier analysis, Vibrations.

The measurement and analysis of dynamic pressures on hydraulic models were studied. When the pressure transducer and the measuring point are connected via a hydraulic tube, distinct distortions of the dynamic pressure signals were produced. A simple, low-cost measuring device was constructed to record dynamic pressure in hydraulic models. Specific equipment was designed to test the frequency response characteristic of the tube and the pressure transducer. Impedance theory was applied to test the practical results of the frequency response. A model of a high-head bottom outlet gate was designed. The pressure signals over a certain time domain were taken on the model and transformed into the frequency domain using a spectrum analyzer and fast Fourier techniques. The power spectra obtained with this method provided a better knowledge of the flow forces that generate vibrations. By comparing the power spectra before and after changing the model, the effectiveness of the changes could be evaluated. (See also W90-04274) (Hammond-PTT)
W90-04298

EARTHQUAKES AND HYDRODYNAMIC PRESSURES ON STRUCTURES.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J.P. Murtha, and T. W. Soong.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 365-385, 4 fig, 36 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Earthquake engineering, *Hydrodynamics, *Mathematical analysis, Pressure distribution, Boundary element methods, Submerged structure.

The major issues involved in determining the hydrodynamic pressures that are produced on hydraulic, coastal and marine structures by earthquakes are discussed. Recently developed methods are presented for calculating hydrodynamic forces on structures of arbitrary geometry in 3-dimensional cases which can be formulated and analyzed using the boundary integral equation approach. Since the hydrodynamic pressures can be computed directly from surface integrals, the dimensionality of the problem is reduced. Compressibility of the water may be included in the analysis through the choice of fundamental solutions. Transmitting boundary models are described to reflect the effect of an infinite region. Computed results with analytical solutions are compared for various 2-dimensional and 3-dimensional shapes. The results are applicable to a variety of hydraulic and marine structures, including gravity platforms and storage tanks. (See also W90-04274) (Hammond-PTT)
W90-04302

USING SUPER COMPUTERS FOR THE TIME HISTORY ANALYSIS OF OLD GRAVITY DAMS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
G. Rouve, and A. Peters.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 387-398, 6 fig, 6 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Computers, *Dam stability, *Materials testing, *Mathematical studies, *Data interpretation, Data acquisition, Finite element method, Simulation analysis, Time series analysis.

Problems related to the maintenance of the 20 Intze-dams (masonry dams in the German state of Nordrhein-Westphalia built in the early 20th century) and a numerical model designed to analyze their safety are presented. The model was based on the Finite Element Method. Input data were supplied from the recorded measurements taken over a period of more than 50 years. The computations

have been applied to finding weak points in a structure, renovation measures, maximum possible loading, probable failure mechanisms, and early warning of acute danger. Due to the complexity of computation when simulating time-dependent events, the model was implemented on the recently developed super-computers CRAY X-MO and CDC-CYBER 205. (See also W90-04274) (Hammond-PTT)
W90-04303

DIRECT BOUNDARY ELEMENT TECHNIQUE FOR COMPUTING WATER WAVES.
North Staffordshire Polytechnic, Stafford (England). Dept. of Mechanical and Computer-Aided Engineering.
T. T. Al-Shemmeri, and O. Hamed.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 399-410, 6 fig, 8 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Wave action, *Mathematical studies, *Hydraulics, *Boundary element methods, Fluid mechanics.

The accuracy and stability of the Boundary Element Method approach to time-varying water waves has been demonstrated by comparisons with known solutions for standing waves. Use of the method for progressive waves in a long tank provided a highly effective numerical wave absorber which was devised to reduce reflections from end walls. The technique also was tested to compute reflections of water waves in the presence of an obstacle and showed agreement with available experimental data. It was not necessary to use any form of stability correction term. (See also W90-04274) (Hammond-PTT)
W90-04304

RESTORATION OF A CONCRETE TUNNEL LINING: THE ROLE OF FIELD MEASUREMENTS IN THE SAFETY AND CONTROL OF THE STRUCTURAL STABILITY.
Ente Nazionale per l'Energia Elettrica, Rome (Italy).
For primary bibliographic entry see Field 8F.
W90-04305

FLUID-STRUCTURE INTERACTION: EXPERIMENTAL AND NUMERICAL ANALYSES.
Centro Informazioni Studi Esperienze, Milan (Italy).
A. Brusa, P. Magliocchi, P. Pezzoli, E. Pizzigalli, and G. Bettinali.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 447-458, 4 fig, 2 tab, 6 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Mathematical models, *Fluid mechanics, *Structural behavior, *Hydrodynamics, Concrete construction, Hydraulic models, Dams, Pressure distribution, Shape, Vibrations.

An experimental and numerical study has been performed to validate a mathematical model for the dynamic analysis of fluid-structure coupled systems. The analysis was performed on a simple experimental apparatus consisting of a flexible carbon steel plate clamped to a rigid concrete container filled with water. Different heights of the water level and different shapes of the container were considered as well as the presence of immiscible fluids in the tank. The results are reported in terms of natural frequencies, displacements and pressure modes. Good agreement between experimental and theoretical results demonstrated that the mathematical model can accurately predict the vibration characteristics of fluid-structure coupled systems. One limitation to this experimental apparatus was that the frequencies of the fluid with the rigid plate were much higher than those of the plate without fluid. The situation is generally different in real dam-reservoir coupled systems for which the two sets of frequencies are always interconnected. With the experimental apparatus, the presence of the fluid may have affected the frequencies as well as the model shape. (See also W90-04274) (Hammond-PTT)
W90-04307

HYDRAULIC DESIGN CONSIDERATIONS AND CONTROL STRUCTURES FOR CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT.
Tennessee Valley Authority, Chattanooga. Water Quality Dept.
For primary bibliographic entry see Field 5D.
W90-04424

HYDRAULIC CONSIDERATIONS AND THE DESIGN OF REED BED TREATMENT SYSTEMS.
Water Research Centre, Stevenage (England).
For primary bibliographic entry see Field 5D.
W90-04452

PERFORMANCE OF SOLID-MATRIX WETLAND SYSTEMS, VIEWED AS FIXED-FILM BIOREACTORS.
Hawkesbury Agricultural Coll., Richmond (Australia). Faculty of Food and Environmental Sciences.
For primary bibliographic entry see Field 5D.
W90-04455

8C. Hydraulic Machinery

INTELLIGENT SELF-IMPROVING CONTROL STRATEGY WITH A VARIABLE STRUCTURE AND TIME-VARYING PARAMETERS FOR WATER TURBINE GOVERNOR.
Calgary Univ. (Alberta).
O. P. Malik, G. S. Hope, L. Ye, S. Wei, and H. Xu.
Houille Blanche HOBLAB, Vol. 1989, No. 6, p 463-475, 1989. 11 fig, 6 tab, 14 ref, 2 append.

Descriptors: *Turbines, *Automation, *Hydroelectric plants, *Control systems, *Computers, Artificial intelligence.

Combining ideas from artificial intelligence, adaptive control and variable structure control, an intelligent self-improving control strategy with both variable structure and parameters is proposed and developed. The connection of the proposed control strategy with multiprocessor-based system will open a new way for the water turbine governing system, probably also for other industrial process control. The proposed intelligent self-improving control strategy synthesizes a priori knowledge and experience, running identification/optimization information as well as analyzing and inferential capacity. The human knowledge accumulated in both theoretical and practical areas, frequent experiment and computation and artificial intelligence are organically connected. The selection of control structure depends on plant structure, operating point and state on the basis of plant structure detection, plant parameter identification and performance detection. Parameter identification is not the starting point of the control determination in each sampling period as is more common, but is a source for improving the knowledge bank contents. The multiprocessor-based system is obligatory for realizing the proposed control strategy because the conventional analog systems are not able to accomplish the complex, intelligent self-improving control algorithm. The proposed hardware configuration is based on an already proven multimicroprocessor-based governor. (Author's abstract)
W90-04119

FIRST STAGE OF RIVER DIVERSION ACCOMPLISHED AT YACYRETA.
Harza y Consorciados, Ituzaingo (Argentina).
For primary bibliographic entry see Field 8A.
W90-04134

CHILE DEVELOPS MORE HYDROPOWER.
Empresa Nacional de Electricidad S.A., Santiago (Chile).
H. Zabaleta G.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 32-34, December 1989. 4 fig.

Descriptors: *Water resources development, *Hydroelectric power, *Chile, *Hydroelectric plants, *Dam construction, River basin development, Foreign construction, Roller-compacted concrete, Lake Chapo, Maule River, Bio-Bio River.

In 1988, 67.8% of total power generation in Chile was from hydropower (2280 MW, with 22 stations of more than 10 MW currently in operation). The country has a considerable amount of untapped potential, equivalent to 133 TWh/year. Three major projects are under construction or planned for the near future, in which the national power corporation ENDESA (Empresa Nacional de Electricidad SA) is involved. (1) At the southern end of the Central Interconnected Transmission System, construction is underway on the 130 MW Canutillar hydroelectric project, 50 km from the city of Puerto Montt; it will exploit the hydro potential of Lake Chapo, a natural reservoir at an elevation of 240 m and 7 km from the estuary of the Reloncavi River. (2) The hydroelectric potential in the upper course of the Maule River is already being exploited by Cipreses (103 MW), Isla, (68 MW) Colbun (400 MW), and Manchicura (90 MW), at present in operation, while Pehuenche (500 MW) is under construction and Curillinque (75 MW) is at the preliminary design stage. (3) The Pangue project, construction of which will start in 1990 with initial operation scheduled for 1995, will be built on the Bio-Bio River, to the southeast of the city of Los Angeles; the installed capacity will be 400 MW, with an annual average generation of 2080 GWh. This scheme will incorporate a 113 m-high roller-compacted concrete dam, the country's first structure of this type. (Sand-PTT)
W90-04135

SOME EXPERIENCES WITH HEAD LOSSES IN LINED TUNNELS IN PERU.
Deutsche Gesellschaft fuer Technische Zusammenarbeit m.b.H., Eschborn (Germany, F.R.).
For primary bibliographic entry see Field 8A.
W90-04139

PARALLEL DECOMPOSITION IN THE OPTIMIZATION OF LARGE SCALE SYSTEMS SUBJECT TO SEVERAL CONDITIONS OF BEHAVIOR.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
L. Chibani.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 45-56, 7 ref.

Descriptors: *Hydraulics, *Computer programs, *Computer-aided engineering, *Optimization, *Mathematical studies, *Computers, Algorithms, Data processing.

A new decomposition technique developed for the optimization of large-scale systems subjected to several conditions of behavior or functions of the system. The move coordination method consists of partitioning a large optimization problem into small subproblems. Each subproblem represents the behavior of the system under one condition. A penalty-relaxation-like method is used to add some coordinating constraints to the solution of each subproblem. These constraints have the function of implementing the effect of one system's behavior on the behavior of the other systems. The solution algorithm solves the subproblems in a cyclic way with an update of certain parameters in the coordinating constraints. The subproblems are solved in a parallel way at the same time in a level called the first-level problem. In contrast to other multilevel decomposition techniques where two levels of optimization are solved, in this approach, no optimization problem is solved in the upper-level. The

upper-level only updates the new parameters of the coordinating constraints obtained from solution of the subproblems at the first level. The algorithm is very convenient for implementation on parallel processing computers (See also W90-04274) (Author's abstract)
W90-04277

PRECONDITIONED CONJUGATE GRADIENT METHOD FOR NUMERICAL SOLUTION OF NAVIER-STOKES EQUATIONS.
Ecole Mohammedia d'Ingenieurs, Rabat (Morocco).
R. Aboulaich, and M. Fortin.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 67-81, 6 fig, 5 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Mathematical models, *Hydraulics, *Navier-Stokes equations, *Computers, Domain decomposition method, Algorithms, Differential equations, Data processing.

The numerical simulation of elliptic partial differential equations implies the solution of very large linear systems. The direct methods are efficient but expensive. A possible alternative is a domain decomposition method, where the large system is decomposed into many small systems. If they are properly connected, computing efforts could be split into pieces that could be dealt with in parallel. A preconditioned conjugate gradient algorithm is presented for a numerical solution of the Navier-Stokes equations of incompressible flow, where the preconditioner considered is Schwarz's type decomposition. The domain decomposition method obtained is competitive with standard models and allows 3-dimensional computations even on relatively small machines. (See also W90-02474) (Hammond-PTT)
W90-04279

8D. Soil Mechanics

DESIGN AND CONSTRUCTION OF COLOMBIA'S GUAVIO DAM.
Ingetec S.A., Bogota (Colombia).
For primary bibliographic entry see Field 8A.
W90-04137

8E. Rock Mechanics and Geology

GEOLOGICAL PROBLEMS AT URUGUA-I RCC DAM.
Bechtel Corp., San Francisco, CA.
J. P. Sollo.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 12, p 36-40, December 1989. 5 fig, 1 tab.

Descriptors: *Urugua-i Dam, *Hydraulic structures, *Geology, *Concrete dams, *Argentina, *Concrete construction, *Dam construction, *Dam foundations, *Dam stability, *Geologic joints, Dam design, River diversion, Diversion structures, Grouting, Seepage, Geological surveys.

Adverse geological conditions were encountered during foundation excavations for the Urugua-i roller-compacted concrete (RCC) dam in Argentina. Urugua-i dam is 76 m high and 678 m long; it is constructed of 585,000 cu m of RCC to a crest elevation of 203 m. River diversion is through the lower right abutment where a four-conduit structure has a design capacity of 2000 cu m/s. During curtain grouting of the diversion channel, weathered rock seams were recognized at elevations 115 m and 105 m. The weathered contact seams within the basaltic foundation rock were obvious seepage paths and when traces of clay were discovered on the fractured rock surfaces, dam stability became a concern. These adverse conditions led to a combined strategy of deep consolidation grouting of the dam foundation and the provision of a conventional concrete shear key. A more-extensive geological investigation before the beginning of construction might have disclosed the significance of the geological features that caused a cost increase and schedule delay as a result of the changes made in foundation treatment at the dam. RCC placement was delayed for five months while the shear-key was being excavated and backfilled. (Sand-PTT)
W90-04136

DIFFICULT FOUNDATIONS CHARACTERIZE THE CASA DE PIEDRA SCHEME.
Casa de Piedra Authority, Bahia Blanca (Argentina).
For primary bibliographic entry see Field 8A.
W90-04138

EARTHQUAKES AND HYDRODYNAMIC PRESSURES ON STRUCTURES.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-04302

SUBSURFACE GEOLOGY OF THE ST. CROIX CARBONATE ROCK SYSTEM: PHASE II.
Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center.
For primary bibliographic entry see Field 2F.
W90-04496

8F. Concrete

REHABILITATION OF PEORIA LOCK USING PREPLACED-AGGREGATE CONCRETE.
Army Engineer District, Rock Island, IL.
G. J. Mech.
The Army Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation Research Program Information Exchange Bulletin, Volume 6, No. 4, October 1989. p 1-4, 4 fig.

Descriptors: *Locks, *Maintenance, *Aggregates, *Illinois, Peoria, Concrete, Hydraulic structures, Costs, Grout.

Peoria Lock and Dam, which was completed in 1939, is located on the Illinois River a few miles downstream from Peoria. The lock is 110 ft wide by 600 ft long with 32-ft high lock walls. The upper and lower guide walls are 500 ft long. During the summer of 1985, Geotechnical Branch personnel performed a concrete condition survey on the lock walls. This survey included reviewing all available reports (basically, periodic inspection reports), visually inspecting and photographing all exposed surfaces, mapping cracks, sounding the surface, and taking cores. The petrographic examination indicated that cycles of freezing and thawing were the predominant cause of damage to non-air-entrained concrete. The depth of deterioration was 7 to 8 inches. Approximately 1 to 2 inches of the lock wall surface had already been lost as a result of surface abrasion of the damaged concrete. Consequently, the total depth of damage was 9 to 10 inches after approximately 48 years. The compressive strength of the sound concrete was 5,500 to 6,500 pounds/sq in. (psi). Because the deterioration was so extensive, a decision was made to completely rehabilitate the lock walls. District personnel decided to use preplaced-aggregate concrete (PAC) for the repair work. Shrinkage for PAC is about one-half or less that of conventional concrete. A minimum of 12 inches of concrete was removed by explosive blasting. High-pressure water was used to clean wall surfaces, and then anchors and reinforcing steel were installed. Forms for the PAC were installed on individual monoliths. Typically the resurfaced areas were about 10 ft high and 40 ft wide. Some defects (vugs) occurred on the concrete surface. Some of the vugs are the result of the method used to vibrate the forms and changing the grout flow requirement from 18 sec to 26 sec. Additionally, in some areas where PAC was to be used, conventional concrete was used because of the extensive armor that was placed in the lock wall, the difficulty in forming the areas, and the need to reopen the lock on time. The PAC surface has been subjected to two winters with cycles of freezing and thawing and two years of abrasion from barge traffic. Up to now the surface has performed well. (Lantz-PTT)
W90-03757

REPAIR OF LARGE CONCRETE STRUCTURES BY EPOXY RESIN BONDING.
Nicholson Construction Co., Bridgeville, PA.
D. A. Bruce.
The Army Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation Research Program Information Exchange Bulletin, Volume 6, No. 4, October 1989. p 4-7, 4 fig, 10 ref.

Descriptors: *Hydraulic structures, *Maintenance, *Concrete, *Epoxy resins, *Grouting, Materials engineering, Grout.

Grouting techniques have long been used to seal leaks in concrete dams. Advances in drilling, grouting and material technologies have been made during the last decade to the extent that the reliable remediation of major high dams can be conducted. It is highly significant that such treatments, usually carried out under extremely adverse conditions, can be used not only to seal off leakages but to bond the structure together again. There are three basic elements in ensuring effective treatment: (1) one must first make every effort to understand the cause of the problem. This understanding involves a detailed review of all the geological, constructional, and behavioral data available. Often this research forms the basis for executing a new phase of exploration (by coring) and monitoring; (2) once the probable cause for the cracking has been determined, the repair material can be selected. The repair material must be a true Binghamian fluid, not a suspension of particles. It must harden as soon as practical after injection to deliberately limit and control flow distances. It must have a reasonably constant and controllable viscosity until hardening; this viscosity must reflect the anticipated crack width. It must have minimal shrinkage on hardening. It must be durable, and it is usually required to bond efficiently to wet surfaces, under high hydrostatic or dynamic heads, often in low temperatures and so must have high tensile and shear strengths. It is usually advantageous to have modulus of elasticity significantly less than that of the concrete. It must have low surface tension in order to ease penetration into fine fissures. It must be easily and safely handled, with minimal environmental problems; and, (3) the performance of the grouting and of the structure should be continuously monitored during the repair. In this way, the grouting parameters can be varied as needed to optimize the procedure. (Lantz-PTT)
W90-03758

SURFACE TREATMENTS FOR CONCRETE.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 8G.
W90-03759

EVALUATION OF ORGANIC MATERIALS THAT INTERFERE WITH STABILIZATION/SOLIDIFICATION PROCESSES.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5G.
W90-03840

RX FOR DAM REPAIR.
Bridgeport Hydraulic Co., CT.
E. M. Bernard.
Civil Engineering (ASCE), CEWRA9, Vol. 59, No. 11, p 44-46, November 1989.

Descriptors: *Dam maintenance, *Concrete dams, *Maintenance, *Connecticut, Deterioration, Concrete construction, Field studies, Construction methods, Materials engineering.

Several factors affect the renovation approach taken at any dam, including the size and geometry of the dam, the depth and extent of concrete deterioration, the extent and source of leakage and the cause of deterioration. It is first necessary to investigate both the cause of the deterioration and the general repair approach before detailed design and construction take place. Two recent projects in Connecticut, at the Easton and Means Brook Dams (Bridgeport Hydraulic Company), demonstrate the importance of this practice. Both structures are concrete gravity dams, both were constructed during the same period, and both exhibited similar freeze/thaw damage. Despite this, the repair approaches taken were different. At Easton dam, it was discovered that concrete and joint deterioration was limited to the upper 25 ft of the dam. This also is the portion subjected to the greatest water temperature differential and fluctuating reservoir levels. Based on this information and joint movement calculations, it was decided to install joint waterstops 35 ft below the top of the dam. Urethane foam grout was installed by soaking burlap rags in the uncured compound and tamping them, one by one, into drill holes. In addition, 3 in of existing concrete had to be removed from the dam crest prior to resurfacing. This was done by hydrodemolition. Reinforcing steel was specified for the new concrete to control shrinkage cracks. Dowels were specified to anchor better the new surface of the existing concrete. With most of the seepage and associated deterioration arrested, there is no urgency to make the remaining repairs. At Means Brook Dam, the downstream surface is vertical, and is battered at 0.7:1 from the toe to distance of approximately 24 ft from the top of the dam. Visual and petrographic analysis showed that Means Brook Dam had been affected only by exposure and weathering. This effect was superficial, caused by freeze/thaw action on saturated or near-saturated, non-air entrained portland cement concrete. After a review of several repair approaches, the consultants recommended installing precast facing panels on the downstream face as the best repair solution. Insulation was used between the panels and the dam to reduce the freeze/thaw cycling. The crest will be resurfaced by removing deteriorated concrete and installing a new layer of cast-in-place concrete, increasing the height of the dam by 4 in. (Rochester-PTT)
W90-03974

CORROSION IN POTABLE WATER SYSTEMS: THE JOHANNESBURG EXPERIENCE.
Johannesburg City Health Dept. Labs. (South Africa).
For primary bibliographic entry see Field 5F.
W90-03988

RESTORATION OF A CONCRETE TUNNEL LINING: THE ROLE OF FIELD MEASUREMENTS IN THE SAFETY AND CONTROL OF THE STRUCTURAL STABILITY.
Ente Nazionale per l'Energia Elettrica, Rome (Italy).
I. Fornero, A. Frassoni, G. Giuseppetti, and G. Mazza.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 411-421, 7 fig, 4 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Concrete technology, *Tunnel linings, *Mathematical studies, *Data acquisition, Stability analysis, Concrete testing, Tunnel failure, Tunnel construction.

The restoration of the structural integrity of a tunnel, which was built in the 1950's and had developed cracking along a considerable stretch, has been analyzed by a numerical identification procedure based both on the location of the observed cracking on the inner facing of the tunnel lining and on laboratory tests carried out on concrete specimens. The uncertainties of the numerical analysis have suggested the installation of several instruments in two critical sections of the tunnel to observe the behavior of the structure after the restoration work and to provide data that might be required at a later stage of the structure life. All the measurements are automatically recorded by a data acquisition system that requires the interfacing of the whole set of transducers with a microcomputer. The interpretation of the measurements will permit verification of the validity of the restoration work and control of the structural stability of the tunnel lining. (See also W90-04274) (Author's abstract)
W90-04305

THERMAL STRESS NUMERICAL ANALYSIS OF A CONCRETE UNDERGROUND DISCHARGE CONTROL.
Istituto Sperimentale Modelli e Strutture S.p.A., Bergamo (Italy).
F. Anesa, E. Falletti, G. Giuseppetti, and G. Mazza.
IN: Computer Methods and Water Resources: First International Conference, Morocco, 1988. Vol. 4, Computer Aided Engineering in Water Resources. Computational Mechanics Publications, Boston. 1988. p 423-434, 9 fig, 2 tab, 3 ref.

Descriptors: *Computer programs, *Computer-aided engineering, *Concrete testing, *Pipelines, *Mathematical studies, *Data acquisition, *Computers, *Thermal pollution, *Thermal stress, Temperature effects, Tensile stress, Data processing.

A thermal stress numerical analysis relevant to a concrete underground channel was developed. The temperature of the water that flows inside the pipeline is roughly 35 C, whereas the environmental temperature (the ground surrounding the channel) is roughly 13 C. Steady-state and transient thermal analyses were carried out to evaluate the effects of the temperatures and their variations on the concrete. Assuming that the behavior of the material is linear and elastic, the stresses caused by the whole set of loadings and the thermal stresses relevant to steady-state and transient thermal analyses can be superimposed. The temperatures obtained using the transient thermal analysis showed tensile stresses in the pipeline roughly 35% greater than the stresses computed using the steady-state thermal field. A data acquisition system was installed to measure the trend of the temperatures in a concrete underground channel system. The central control unit is a microcomputer that stores the temperature values received from the remote measurement unit. The storage is slow (some hours) during the steady-state phase and fast (some minutes) during the transient phase. The remote measurement unit converts the analogue signals received from the temperature sensors into digital data. The sensors are platinum resistance thermometers embedded into the concrete and into the soil close to the outer facings of the channel system. The data acquisition system will be fully operational in 1989; no results are currently available. (See also W90-04274) (Hammond-PTT)
W90-04306

8G. Materials

REPAIR OF LARGE CONCRETE STRUCTURES BY EPOXY RESIN BONDING.
Nicholson Construction Co., Bridgeville, PA.
For primary bibliographic entry see Field 8F.
W90-03758

SURFACE TREATMENTS FOR CONCRETE.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. B. Husbands, and F. E. Causey.
The Army Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation Research Program Information Exchange Bulletin, Volume 6, No. 4, October 1989. p 8-11, 2 tab.

Descriptors: *Concrete construction, *Materials testing, *Sealants, *Surface sealing, Acrylics, Hydrocarbons, Polyurethane, Silanes, Silicones, Siloxanes, Stearates.

Freezing and thawing, penetration of salts, weathering, chemical attack, and erosion cause concrete surfaces to deteriorate. Surface treatment of the concrete with a material more resistant to these forces than concrete can slow or even eliminate the rate of deterioration. Surface treatment materials were separated according to viscosity, total solids, manufacturers' recommended use, and chemical composition. Those tested fell into eight generic types: (1) acrylic, (2) hydrocarbon, (3)linseed oil, (4) polyurethane, (5) silane, (6) silicone, (7) siloxane, and (8) stearate. Results of the study indicate: siloxanes perform well as a generic-type concrete sealer, except in resisting cycles of freezing and thawing; acrylic mastic coatings for treatment of cracked concrete tested well in the laboratory, but field application results are not available; polyester resin coatings tested can be used effectively as abrasion-resistant coatings if applied to dry concrete; only those polyurethanes recommended by manufacturers for sealing concrete surfaces subjected to vehicular traffic performed effectively in laboratory tests; the high-molecular-weight methacrylate (HMWM) monomer systems can be used to seal cracks by topical application; two cementitious coatings tested were found effective for waterproofing concrete, from both positive and negative sides, and may minimize concrete deterioration resulting from freezing and thawing. Others tested did not produce the desired results; the addition of latex admixtures improves the freeze-thaw durability of shotcrete; and polypropylene fibers appear to reduce cracking caused by drying and shrinkage in latex-modified shotcrete. (Author's abstract)
W90-03759

WATER MAINS: REHABILITATION AND MATERIALS REVIEW.
WRc Engineering, Swindon (England).
For primary bibliographic entry see Field 5F.
W90-03967

CORROSION IN POTABLE WATER SYSTEMS: THE JOHANNESBURG EXPERIENCE.
Johannesburg City Health Dept. Labs. (South Africa).
For primary bibliographic entry see Field 5F.
W90-03988

INFLUENCE OF MATERIALS ON THE MICROBIOLOGICAL COLONIZATION OF DRINKING WATER.
Bonn Univ. (Germany, F.R.). Hygiene Inst.
For primary bibliographic entry see Field 5B.
W90-04008

PROTECTIVE COATINGS AT A WASTEWATER TREATMENT PLANT.
Willow Lake Wastewater Treatment Plant, Salem, OR.
For primary bibliographic entry see Field 5D.
W90-04115

USING SUPER COMPUTERS FOR THE TIME HISTORY ANALYSIS OF OLD GRAVITY DAMS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 8B.
W90-04303

8I. Fisheries Engineering

CHANGES IN FISH STOCKS AND FISHERIES: THE LOWER ELBE RIVER.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 2E.
W90-03701

HISTORICAL CHANGES IN THE FISH FAUNA OF THE RIVER DUERO BASIN.
Museo Nacional de Ciencias Naturales, Madrid (Spain).
J. Lobon-Cervia, B. Elvira, and P. A. Rincon.
IN: Historical Change of Large Alluvial Rivers:

Western Europe. John Wiley & Sons, New York. 1989. p 221-232. 4 fig, 2 tab, 45 ref.

Descriptors: *History, *River basins, *Fish stocking, *Fish populations, *Ecological effects, Taxonomy, Topography, Fish migration, Spain, Portugal, Duero River.

The drainage basin of the Duero River is shared between Spain and Portugal. Although sharing a topographic divide, the fish fauna of the Duero and Ebro River differ markedly. Moreover, unlike the Ebro, there is a valuable taxonomic record for assessing historical change in the Duero River. The fish species of the Duero River can be classified into three groups: (1) freshwater species, (2) migratory species, both catadromous and anadromous, and (3) eurihaline species. The freshwater species is of major concern because this group has been subjected to more important historical changes than any other group. The greatest impact of man upon the fish fauna of the Duero over the historic timescale has been stocking with exotic species. The problem remains that fish management is not based on scientific arguments but on the stocking of any river or stream without considering the status of the existing population. (See also (W90-03689) (Fish-PTT)
W90-03702

FISH AND FISHERIES OF THE RIVER EBRO: ACTUAL STATE AND RECENT HISTORY.
Barcelona Univ. (Spain). Dept. of Animal Biology.
A. de Sostoa, and J. Lobon-Cervia.
IN: Historical Change of Large Alluvial Rivers: Western Europe. John Wiley & Sons, New York. 1989. p 233-247. 4 fig, 3 tab, 15 ref.

Descriptors: *Fish management, *Ebro River, *Fish populations, *Fish stocking, *Fisheries, *History, Commercial fishing, Fishing gear, Nets, Trapping, Lagoons, Channels, Fish migration, Water management, Water pollution effects, Spain.

In comparison with other Iberian river systems, the Ebro River (Spain) is richest in number of species (anadromous, catadromous, and euryhaline). According to their origin, the fish fauna can be divided into five groups: (1) Mediterranean, (2) Iberian/North African, (3) mid-northern European, (4) all anadromous and catadromous species, and (5) all introduced species. Professional freshwater fisheries were common on the Ebro until the 1960s. From a zoogeographical point of view, the fish fauna of the Ebro Delta is composed of mediterranean-boreal and mediterranean-lusitanian taxa. Professional fisheries have been reported in the Ebro Delta since the 17th century, but became organized only in 1879, when the state administration began regulating fish yield, amount, and season. Basically, two fishing methods are used in the coastal lagoons: those using nets or line and hooks, and traps. Year-to-year variations in the total yield obtained from these lagoons show that between 1965 and 1972, the annual yield increased progressively. However, from 1972 to 1980 the yield decreased sharply. Three main reasons have contributed to this change: (1) after 1972 fishermen decided to leave the fishing gear in the channels connecting the sea with the lagoons, rather than removing them as before, effectively restricting fish migration; (2) the overfishing problem; and (3) a general lack of science in management policy, together with the increasing impact of increasing pollution, contributing to changing fish stocks. (See also (W90-03689) (Fish-PTT)
W90-03703

ASSESSMENT OF BUFFALO FISHERIES RESOURCES IN A MISSISSIPPI STREAM THREE DECADES AFTER CHANNELIZATION.
Mississippi State Univ., Mississippi State. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 6G.
W90-03709

POOL-ORIFICE AND POOL-ORIFICE-WEIR FISHWAYS.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
N. Rajaratman, C. Katopodis, and A. Mainali.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 5, p 774-777, October 1989. 2 fig, 7 ref.

Descriptors: *Fish passages, *Weirs, *Flow rates, *Orifice flow, *Hydraulic engineering, Fish ladders, Fish barriers, Open-channel flow, Turbulent flow, Flow characteristics, Mathematical analysis.

This technical note presents a method of analyzing the flow in pool-orifice fishways by dividing it into vertical slot and submerged orifice flow regimes. There is a transition state between the regimes, and flow equations have been developed for both the end states. For a pool-orifice-weir fishway, with flow through the orifice and over the weir, a method has been suggested for predicting the total flow rate in the fishway. It was found that the total flow rate is approximately equal to the sum of the (uncoupled) flows through the orifices and over the weirs. Experimental observations supported these methods. (Author's abstract)
W90-04025

COARSE WOODY DEBRIS AND CHANNEL MORPHOLOGY: A FLUME STUDY.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
J. Cherry, and R. L. Beschta.
Water Resources Bulletin WARBAQ, Vol. 25, No. 5, p 1031-1036, October 1989. 3 fig, 1 tab, 21 ref.

Descriptors: *Stream fisheries, *Channel morphology, *Flow characteristics, Scour, Simulation analysis, Flow around objects, Stability, Detritus.

In recent years, logs and other structures have been added to streams for the purposes of altering channel morphology to improve fish habitat. This flume study was conducted to evaluate the effects of coarse woody debris on local channel morphology. Wooden dowels were used to simulate the effects of individual logs in a stream, and scour depth and surface area were determined at the end of each test run. The maximum scour depth was significantly correlated (90 percent confidence level) with both the vertical orientation of the dowels and the channel opening ratio; the scour surface area was significantly correlated (90 percent confidence level) with both the flow depth and the vertical orientation. Upstream-oriented dowels caused relatively large streambed scour and also deflected flows toward the streambank. Downstream-oriented dowels generally caused less bed scour and appeared to provide better bank protection because flow was generally deflected from the bank. In conjunction with data from field studies, these results provide information on the effects of orientation, hydraulic function, and relative stability of coarse woody debris in streams. (Author's abstract)
W90-04207

ROCK ISLAND DAM SMOLT MONITORING, 1987.
Public Utility District No. 1 of Chelan County, Wenatchee, WA. Power Operations Dept.
C. M. Peven, D. H. Sheffield, and P. C. Fielder.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-001538. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/BP/61748-2, September 1987. Final Report. 46p, 9 fig, 5 tab, 5 ref. DOE Contract DE-AI79-86BP61748. DOE Project 84-54.

Descriptors: *Dam effects, *Salmon, *Trout, Rock Island Dam, Monitoring, Fish migration, Fish populations, Chinook, River flow.

Downstream migrating salmon and steelhead trout smolts were monitored at the Rock Island Dam bypass trap from April 1 through August 31, 1987. Data collected included: (1) number of fish caught by species, (2) number of branded fish caught by species, (3) daily average river flow, (4) daily average powerhouse No. 1 and No. 2 flows and daily average spill. These data were transmitted to, and used by, the Fish Passage Center to manage a 'water budget' of allocated upstream water storage to augment river flows to improve survival of downstream migrating salmonids. The Rock Island Dam trapping facility collected 84,687 downstream migrating salmonids in 1987. Collected fish included 412 chinook salmon and 638 steelhead which had been freeze branded (to determine migration rates) and 608 chinook and 16,519 steelhead with clipped adipose fins. The middle 80% of the 1987 spring migration (excluding sub-yearling chinooks) passed Rock Island Dam during a 30 day period, April 27-May 26. Passage rates of hatchery released chinook and steelhead smolts and downstream migration timing of all salmonids are tabulated. Sub-yearling chinook comprised 17% of the fish collected at Rock Island Dam. (Author's abstract)
W90-04220

EVALUATION OF FISHWAY DESIGNS FOR DOWNSTREAM PASSAGE OF SPRING CHINOOK SALMON AND STEELHEAD TROUT SMOLTS, 1987.
Idaho Univ., Moscow. Coll. of Forestry, Wildlife and Range Sciences.
J. L. Congleton, E. J. Wagner, and R. R. Ringe.
Available from the National Technical Information Service, Springfield, VA 22161, as DE89-001554. Price codes: A04 in paper copy, A01 in microfiche. Final Report No. DOE/BP/64234-1, March 1988. 53p, 5 fig, 16 ref, 3 append. DOE Contract DE-AI79-86BP64234 and Project 86-47.

Descriptors: *Salmon, *Fish passages, *Fish physiology, *Trout, Diel variation, Fisheries, Fish migration, Design standards, Performance evaluation, Flumes.

The stress response of chinook salmon and steelhead trout smolts to passage through three different flumes was tested by assaying plasma cortisol concentrations before and after flume passage. In addition, descaling of fish was recorded before and after flume passage, and the ability of the flumes to pass adult chinook salmon and debris was determined. Plasma cortisol concentrations were not significantly elevated in chinook salmon smolts after passage through any of the flumes ($P>0.2$). In daytime tests of partially and completely darkened flumes cortisol concentrations were consistently decreased following flume passage. Total darkening of the flumes during daytime was beneficial: cortisol concentrations were lower ($P=0.03$) in chinook salmon smolts passing through completely darkened flumes than in smolts passing through partially darkened flumes. In steelhead trout smolts, plasma cortisol concentrations were significantly elevated after passage through the flumes, and flume design did have a significant effect ($P<0.0001$). Complete darkening of the flumes during daytime tests did not have a significant effect on cortisol concentrations ($P=0.4$). Plasma cortisol concentrations were significantly higher in daytime than in nighttime samples of chinook salmon smolts held in darkened and undarkened tanks and raceways. This diel cortisol cycle was unaffected by light intensity. The cortisol response to passage through darkened flumes was greater in nighttime than in daytime tests with both species. None of the flumes tested caused descaling of fish. Descaling was measured in two ways: as mean percent of body area descaled, and as the percent of fish in a sample with > 5% descaling in any of 10 body zones. Neither of these descaling measures was significantly increased after flume passage, and flume design did not have a significant effect. (Lantz-PTT)
W90-04262

HISTORICAL PERSPECTIVE ON FISH SPECIES COMPOSITION AND DISTRIBUTION IN THE HUDSON RIVER ESTUARY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 2L.
W90-04507

DISTRIBUTIONS OF EARLY LIFE STAGES OF STRIPED BASS IN THE HUDSON RIVER ESTUARY, 1974-1979.

National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
For primary bibliographic entry see Field 2L.
W90-04509

STOCK CHARACTERISTICS OF HUDSON RIVER STRIPED BASS.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 2L.
W90-04510

ADVANCES IN FIELD AND ANALYTICAL METHODS FOR ESTIMATING ENTRAINMENT MORTALITY FACTORS.
EA Engineering, Science, and Technology, Inc., Middletown, NY.
P. H. Muessig, J. R. Young, D. S. Vaughan, and B. A. Smith.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 124-132. 7 fig, 1 tab, 20 ref. DOE 40-550-75, Union Carbide Corp. Contract W-7405-eng-26, DOE 40-1054-79.

Descriptors: *Environmental effects, *Nuclear powerplants, *Thermal powerplants, *Powerplant effects, *Entrainment, *Estuarine fisheries, Hudson River, Mortality, Statistical analysis.

The hearings and settlement negotiations in the Hudson River case focused on various modeling input factors for calculating reduction in year-class strength of important fish species in the Hudson River due to power plant operations. One of the inputs that received considerable attention, and about which the various parties to the case came to general agreement, was the entrainment mortality factor, or f-factor, the probability that an entrained live organism will be killed as a result of its passage through a power plant in the condenser cooling water. Entrainment mortality includes death due to temperature increases and death due to mechanical processes. The convergence of views about the f-factor arose from increased understanding of the sources of estimation error, improvements in gear for collection of fish larvae, and development of a model for the thermal component of entrainment mortality. Improvements in sampling-gear design reduced potential biases in mortality estimates, reduced estimates of mechanical mortality from 0.923 to 0.412, and improved the statistical power to detect entrainment mortality and the precision of mortality estimates. (See also W90-04505) (Author's abstract)
W90-04512

HISTORICAL DEVELOPMENT OF ENTRAINMENT MODELS FOR HUDSON RIVER STRIPED BASS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. W. Christensen, and T. L. Englert.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 133-142. 4 fig, 1 tab, 29 ref. DOE 40-544-75, DOE 40-740-78, Contract DE-AC05-840R21400.

Descriptors: *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Striped bass, *Hudson River Estuary, *Environmental effects, *Entrainment, Model studies, Empirical models, Transport models, Life history studies.

In the mid-1960s, concerns surfaced regarding entrainment and impingement of young-of-the-year (age-0) striped bass by electric power generating facilities on the Hudson River. These concerns stimulated the development of increasingly complex models to evaluate the impacts of these facilities. The earliest simplistic formulas, based on empirical data, proved inadequate because of conceptual shortcomings, incomplete development, and lack of data. By 1972, complex transport models based on biological and hydrodynamic principles had been developed and applied by scientists representing both the utilities and the government. Disagreements about the acceptability of these models spurred the development of even more complex models. The entrainment models stimulated the collection of substantial amounts of field data to define the spatial distributions and entrainment survival of early life stages. As the difficulties of accounting for the movement of early life stages from hydrodynamic principles became more evident and as more field data became available, simpler empirical modeling approaches became both practical and defensible. Both empirical and hydrodynamic modeling approaches were applied during the U.S. Environmental Protection Agency's hearings on the Hudson River power case (1977-1980). The main lessons learned from the experience with entrainment-impingement modeling are that complex mechanistic models are not necessarily better than simpler empirical models for young fish, and that care must be taken to construct even the simple models correctly. (See also W90-04505) (Author's abstract)
W90-04513

HISTORICAL REVIEW OF ENTRAINMENT IMPACT ESTIMATES AND THE FACTORS INFLUENCING THEM.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
T. L. Englert, and J. Boreman.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 143-151. 2 fig, 1 tab, 18 ref.

Descriptors: *Environmental effects, *Nuclear powerplants, *Powerplant effects, *Thermal powerplants, *Entrainment, *Striped bass, *Hudson River Estuary, Mathematical models, Mortality, Data interpretation, Indian Point Nuclear Plant.

Estimates of entrainment mortality have played a key role in the Hudson River power plant case since the late 1960s. The estimates of entrainment mortality of striped bass due to the operation of Indian Point nuclear plant were first presented by utility and government consultants in 1972. These estimates were derived with the first of many generations of mathematical models. Assumed values had to be used for some of the critical parameters because of the limited amount of data available. The government estimates were much higher as a result of the intentional use of conservative assumptions. As more data became available and model formulations evolved, fewer assumptions were needed, the government estimates declined, and the gap between estimates from the two groups of consultants narrowed markedly. Several factors contributed to the convergence of model estimates, but a key factor was field data showing that more than half of the entrained striped bass survive passage through the plant. The convergence of estimates of entrainment mortality was a key ingredient in the eventual formulation of the settlement agreement and showed that progress had been made in resolving an important portion of the heavily contested issues. (See also W90-04505) (Author's abstract)
W90-04514

ESTIMATES OF ENTRAINMENT MORTALITY FOR STRIPED BASS AND OTHER FISH SPECIES INHABITING THE HUDSON RIVER ESTUARY.
National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.
J. Boreman, and C. P. Goodyear.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 152-160. 7 tab, 18 ref.

Descriptors: *Hudson River Estuary, *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Estuarine fisheries, *Environmental effects, *Entrainment, Mortality, Striped bass, Perch, Atlantic tomcod, Shad, River herring, Bay anchovy.

An empirically derived age-, time-, and space-variant equation was used to estimate entrainment mortality at power plants for seven fish species inhabiting the Hudson River estuary. Entrainment mortality is expressed as a conditional rate, which is the fractional reduction in year-class strength due to entrainment if other sources of mortality are density-independent. Estimates of the conditional entrainment mortality, based on historical and projected once-through cooling operation of five power plants, were 11-22% for striped bass, 11-17% for white perch, 5-7% for Atlantic tomcod, 14-21% for American shad, 4-11% for river herring (alewife and blueback herring combined), and 35-79% for bay anchovy. Closed-cycle cooling (natural-draft cooling towers) at three of the power plants (Indian Point, Bowline Point, and Roseton) would reduce entrainment mortality of striped bass by 50-80%, of white perch by 75-80%, of Atlantic tomcod by 65-70%, of American shad by 80%, of river herring by 30-90%, and of bay anchovy by 45-80%. The life stages most vulnerable to entrainment mortality were post-yolk-sac larva and entrainable size juvenile. (See also W90-04505) (Author's abstract)
W90-04515

RELIABILITY OF IMPINGEMENT SAMPLING DESIGNS: AN EXAMPLE FROM THE INDIAN POINT STATION.
Normandeau Associates, Inc., Bedford, NH.
M. T. Mattson, J. B. Waxman, and D. A. Watson.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 161-169. 1 fig, 6 tab, 14 ref.

Descriptors: *Powerplant effects, *Sampling, *Thermal powerplants, *Nuclear powerplants, *Hudson River Estuary, *Impingement, *Estuarine fisheries, *Data acquisition, *Data interpretation, *Environmental effects, Indian Point Nuclear Plant, Sampling.

A 4-year data base (1976-1979) of daily fish impingement counts at the Indian Point electric power station on the Hudson River was used to compare the precision and reliability of three random-sampling designs: (1) simple random, (2) seasonally stratified (by 3-month periods), and (3) empirically stratified (based on trends in daily impingement variation). The precision of daily impingement estimates improved logarithmically for each design as more days in the year were sampled. Simple random sampling was the least, and empirically stratified sampling was the most precise design, and the difference in precision between the two stratified designs was small. Computer-simulated sampling was used to estimate the reliability of the two stratified-random-sampling designs. A seasonally stratified sampling design was selected as the most appropriate reduced-sampling program for Indian Point station because: (1) reasonably precise and reliable impingement estimates were obtained using this design for all species combined and for eight common Hudson River fish by sampling only 30% of the days in a year (110 d); and (2) seasonal strata may be more precise and reliable than empirical strata if future changes in annual impingement patterns occur. The seasonally stratified design applied to the 1976-1983 Indian Point impingement data showed that selection of sampling dates based on daily species-specific impingement variability gave results that were more precise, but not more consistently reliable, than sampling allocations based on the variability of all fish species combined. (See also W90-04505) (Author's abstract)
W90-04516

SURVIVAL OF FISHES AFTER IMPINGEMENT ON TRAVELING SCREENS AT HUDSON RIVER POWER PLANTS.
EA Engineering, Science, and Technology, Inc., Middletown, NY.
P. H. Muessig, J. B. Hutchison, L. R. King, R. J. Ligotino, and M. Daley.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 170-181. 9 fig, 4 tab, 24 ref.

Descriptors: *Estuarine fisheries, *Hudson River estuary, *Entrainment, *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Environmental effects, *Impingement, Rotating screens, Atlantic tomcod, Striped bass, White perch, Bay anchovy, Alewife, Herring.

The survival of Hudson River fishes, juveniles and adults, after they had been impinged on continuously rotated traveling screens at the Bowline Point and Danskammer Point power plants was examined. Survival of principal species was similar at the two plants, and estimates of survival improved as monitoring stress was reduced. Adjusted for survival of control fish, survival over 84-108 h after fish were recovered from the screens was highest for Atlantic tomcod, striped bass, and white perch (50-90%) and lowest for bay anchovy, alewife, and blueback herring; other species showed intermediate survival. Survival of striped bass and white perch was positively correlated with water temperature in winter and with conductivity in spring and fall. Continual rotation of the screens, which shortens the average time that fish are impinged, increased survival over that associated with intermittent rotation. (See also W90-04505) (Author's abstract)
W90-04517

ANALYSIS OF IMPINGEMENT IMPACTS ON HUDSON RIVER FISH POPULATIONS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 6G.
W90-04518

DEVELOPMENT AND SENSITIVITY ANALYSIS OF IMPACT ASSESSMENT EQUATIONS BASED ON STOCK-RECRUITMENT THEORY.
Texas Instruments, Inc., Buchanan, NY. Ecological Services Group.
For primary bibliographic entry see Field 6G.
W90-04519

SOME CONSIDERATIONS IN APPLYING STOCK-RECRUITMENT MODELS TO MULTIPLE-AGE SPAWNING POPULATIONS.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
P. J. Lawler.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 204-218. 3 tab, 15 ref.

Descriptors: *Environmental effects, *Hudson River Estuary, *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Estuarine fisheries, Model studies, Population studies, Mortality, Data interpretation, Environmental impact.

Several approaches used during the Hudson River power plant hearings (1977-1980) to permit quantitative estimation of the impact of power plant operation on the river's striped bass population are presented. The Ricker stock-recruitment model was adopted as a starting point to provide a reasonable working conceptualization of the stock-recruitment processes operating in this river. This model was then modified in a variety of ways to reflect multiple-age spawning by striped bass, and the results were fit to data on the river's commercial striped bass catch and effort, organized to reflect certain average age distribution parameters. Environmental variation in the system, represented in an overall fashion by the spring and summer variation in the river's freshwater flow, and the effect of certain assumed modes of cannibalism were also included in these analyses. Quantitative estimates of the Ricker parameters alpha and beta representing 'compensatory reserve' and density-dependent mortality, respectively, in the system were extracted from these fits. In addition, an approach to modeling the influence of certain density-dependent and density-independent growth factors on the various modes of mortality is presented. All of the above procedures are directed toward estimating the change a given impact may induce on the stock-recruitment model parameters alpha and beta. These changes in alpha and beta are used in various equilibrium reduction models to estimate the percentage change in the equilibrium spawning population that, all other things remaining equal, can be expected in the presence of the impact under study. (See also W90-04505) (Author's abstract)
W90-04520

TESTING THE VALIDITY OF STOCK-RECRUITMENT CURVE FITS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. W. Christensen, and C. P. Goodyear.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 219-231. 2 fig, 3 tab, 39 ref, append. DOE 40-544-75, DOE 40-740-78(EPA 79-D-X0533), DE-AC05-84OR21400.

Descriptors: *Environmental effects, *Estuarine fisheries, *Hudson River Estuary, *Striped bass, *Environmental impact, Ricker stock-recruitment model, Population studies, Simulation models.

The utilities relied heavily on the Ricker stock-recruitment model as the basis for quantifying biological compensation in the Hudson River power case. They presented many fits of the Ricker model to data derived from striped bass catch and effort records compiled by the National Marine Fisheries Service. Based on this curve-fitting exercise, a value of 4 was chosen for the parameter alpha (the balance between fecundity and density-independent mortality) in the Ricker model, and this value was used to derive the utilities' estimates of the long-term impact of power plants on striped bass populations. A technique was developed and applied to address a single fundamental question: If the Ricker model were applicable to the Hudson River striped bass population, could the estimates of alpha from the curve-fitting exercise be considered reliable. The technique involved constructing a simulation model that incorporated the essential biological features of the population and simulated the characteristics of the available actual catch-per-unit-effort data through time. The ability or failure to retrieve the known parameter values underlying the simulation model via the curve-fitting exercise was a direct test of the reliability of the results of fitting stock-recruitment curves to the real data. The results demonstrated that estimates of alpha from the curve-fitting exercise were not reliable. The simulation-modeling technique provides an effective way to identify whether or not particular data are appropriate for use in fitting such models. (See also W90-04505) (Author's abstract)
W90-04521

FISHING IN DANGEROUS WATERS: REMARKS ON A CONTROVERSIAL APPEAL TO SPAWNER-RECRUIT THEORY FOR LONG-TERM IMPACT ASSESSMENT.
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
R. I. Fletcher, and R. B. Deriso.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 232-244. 1 fig, 21 ref, append.

Descriptors: *Environmental effects, *Estuarine fisheries, *Hudson River Estuary, *Thermal powerplants, *Nuclear powerplants, *Fish populations, Environmental impact, Model studies, Spawner-recruit models, Fish management.

In the Hudson River power plant case, the defending utility companies appealed to the (perceived) practices of commercial fishery managers as precedent for their own uses of spawner-recruit models in forecasting the effects on stock abundances of long-term water withdrawals by the power plants. In contrast to this perception of spawner-recruit models as commonly accepted instruments of fishery management, the present survey of managers and regulatory agencies revealed instead a universal rejection of such models. The inadequacies of spawner-recruit (or parent-progeny) models were attributed variously to the effects of environmental uncertainty, to imperfect knowledge of population regulation, and to the lack of sufficient biological meaning in the models themselves. In general, impact assessment little resembles fishery regulation because the options and privileges commonly exercised by a fishery manager are closed to impact management. In either case, long-term forecasting remains unreliable due to the problem, as yet unsolved, of predicting reproduction and recruitment in natural populations. (See also W90-04505) (Author's abstract)
W90-04522

IMPLICATIONS OF POWER PLANT MORTALITY FOR MANAGEMENT OF THE HUDSON RIVER STRIPED BASS FISHERY.
Fish and Wildlife Service, Ann Arbor, MI.
C. P. Goodyear.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 245-254. 5 fig, 4 tab, 26 ref.

Descriptors: *Environmental effects, *Powerplant effects, *Thermal powerplants, *Nuclear powerplants, *Hudson River Estuary, *Striped bass, *Fish management, Fish populations, Mortality.

The Atlantic coastal stock of striped bass apparently declined from colonial times to the early 1930s and subsequently recovered. The reasons for the decline and recovery are not known, but fishing remains a possible explanation, which would suggest population sensitivity to increased mortality. Evidence suggests that fishing mortality has been increasing in recent years and will continue to increase in the absence of management intervention. The consequence of increased fishing mortality is an increase in the marginal effect of the power plant mortality which based on the utilities' models and parameter fits, could result in important reductions in the Hudson River striped bass population. Any management actions imposed to arrest population decline or to increase yield per effort in the fishery would be required to mitigate the impact of the power plants by reducing fishing mortality. It is estimated that a 20% conditional power plant mortality is equivalent to a 14% increase in the number of average fishermen using the stock. Consequently, should any management intervention be required on behalf of the population, managers would be required to reduce fishing mortality by about 14% just to account for the power plant mortality. (See also W90-04505) (Author's abstract)
W90-04523

PLANT FLOW REDUCTIONS AND OUTAGES AS MITIGATIVE MEASURES.
Lawler, Matusky and Skelly Engineers, Pearl River, NY.
For primary bibliographic entry see Field 6F.
W90-04525

EVALUATION OF A BARRIER NET USED TO MITIGATE FISH IMPINGEMENT AT A HUDSON RIVER POWER PLANT INTAKE.
Orange and Rockland Utilities, Inc., Pearl River, NY.
J. B. Hutchison, and J. A. Matousek.
IN: Science, Law and Hudson River Power Plants: A Case Study in Environmental Impact Assessment. American Fisheries Society, Bethesda, Maryland. 1988. p 280-285. 3 fig, 4 tab, 10 ref.

Descriptors: *Hudson River Estuary, *Estuarine fisheries, *Thermal powerplants, *Nuclear powerplants, *Impingement, *Environmental effects, Mitigation measures, Fish populations, Nets, Survival.

A multifilament nylon net of 0.95-cm bar mesh was deployed as a physical barrier to fish in front of the Bowline Point power plant cooling water intake on the Hudson River from 1976 to 1985. The barrier net was deployed during the historical peak impingement months of October-May. The primary species impinged on the intake screens during this period were young-of-year and yearling white

perch, striped bass, rainbow smelt, alewife, blueback herring, and American shad, generally ranging from 5 to 10 cm in total length. When the barrier net was deployed, median impingement of all fish was 91% lower than during comparable periods before the net was installed. A mark-recapture population estimate indicated that 230,000 yearling striped bass and white perch were in the embayment outside the net in April 1982; over a 9-d study period, only 1.6% of this estimated population was impinged. Concurrent survival probability studies of fish marked and released at locations inside and outside the barrier net showed that fish released inside had 72% lower survival ($P</=0.0001$) than those released outside the net. Gill-net catches were significantly lower inside than outside the net ($P</=0.05$). This study led to improvements in barrier-net deployment, including changes in the anchoring system, use of a debris boom, installation of an air-bubbler system to prevent ice accumulation, and sectioning of the net to facilitate removal and cleaning. (See also W90-04505) (Author's abstract)
W90-04526

9. MANPOWER, GRANTS AND FACILITIES

9B. Education (In-House)

MANAGING WATER SUPPLY: PUBLIC OR PRIVATE.
Water Training, Tadley Court, Tadley Common Road, Tadley, Basingstoke, Hants RG26 6TB, UK.
For primary bibliographic entry see Field 5F.
W90-03970

9C. Research Facilities

ARTIFICIAL INTELLIGENCE APPLICATIONS IN ENGINEERING DESIGN: RESEARCH AT M.I.T.
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 8A.
W90-04287

9D. Grants, Contracts, and Research Act Allotments

U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM FISCAL YEAR 1988.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 10C.
W90-03814

FISCAL YEAR 1988 PROGRAM REPORT (INDIANA WATER RESOURCES REPORT CENTER).
Purdue Univ., Lafayette, IN. Water Resources Research Center.
J. R. Wright.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-236749/AS, price codes: A03 in paper copy, A01 in microfiche. 23rd Annual Report, Report No. G1561-01, August 1989. 35p. USGS Project no. G1561-01.

Descriptors: *Water resources institutes, *Research, *Information transfer, *Training, *Indiana, Education, Projects.

The 1988 program of the Indiana Water Resources Research Center (WRRC), located at Purdue University, revolved around three research projects. The projects are as follows. Ronald F. Turco conducted research that provided a characterization of the microbial factors in soil that affect movement of agricultural chemicals from the root zone through the vadose zone to groundwater. Steven J. Fritz led a project which resulted in estimates of groundwater recharge rates through glacial tills, which are of significant importance in calculating the water budget in areas where contaminants are identified. The second year of a two year research project was completed by Victor J. Bierman, Jr. The second year research expanded on that of the first to include an evaluation of optimal load estimation methods under a wide range of hydrologic conditions. These methods can be directly used in the application of models for toxicant mass balances and waste load allocations for inland lakes, nearshore embayments, and the Great Lakes. They can also be used to conduct retrospective studies with existing data or to design sampling programs for new studies. The Center's technology transfer program involved meetings with various national, state, and private entities, invited presentations to various groups, and newsletters and technical reports. (USGS)
W90-03887

FISCAL YEAR 1988 PROGRAM REPORT (MARYLAND WATER RESOURCES RESEARCH CENTER).
Maryland Univ., College Park. Water Resources Research Center.
R. E. Menzer.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-237259/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1567-01,July 1989. 24p. USGS Contract no. 14-08-0001-G1567. USGS Project no. G1567-01.

Descriptors: *Water resources institutes, *Research, *Information transfer, *Training, *Maryland, Education, Projects.

In response to the priorities and goals for 1988 of the Maryland Water Resources Research Center, four research projects and an information transfer project were supported. The projects dealt with sedimentation, nitrogen and phosphorus leaching resulting from agricultural practices, toxic metal deposition in reservoirs and the Chesapeake Bay, and the recovery of submerged aquatic vegetation in the Chesapeake Bay. Analysis of sedimentation in the South River estuary indicated significant cliff erosion in the late 1800's and considerable loss of marsh area offset by new marsh formation resulting from highway construction over the last fifty years. In agricultural field studies to compare the impact of tillage practices on water quality, analysis of soil and groundwater samples indicated higher and more variable levels of nitrate under conventional tillage than in conservation tillage. In mesocosm studies of submerged aquatic vegetation in the Chesapeake Bay, increased loading of N and P both resulted in significant increases of total biomass of epiphytic algae. However, field studies showed that submerged aquatic vegetation growth was limited by the availability of N and P. Thus, the question of nutrient availability is crucial in the balance of algae versus vascular plant growth. Examination of cores from three sites on the western shore of the Chesapeake Bay and one site on the Eastern Shore for lead, cooper, and zinc revealed much higher levels on the western shore. Results for lead indicate that at least for this one element, environmental controls have resulted in substantially lower inputs to the aquatic environment. (USGS)
W90-03888

FISCAL YEAR 1988 PROGRAM REPORT (MICHIGAN INSTITUTE OF WATER RESEARCH).
Michigan State Univ., East Lansing. Inst. of Water Research.
J. F. Bartholic.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-237275/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report 88-G1569-01, March 1989. 35p. USGS Contract no. 14-08-0001-G1569. USGS Project no. G1569-01.

Descriptors: *Water resources institutes, *Michigan, *Information transfer, *Training, Research, Education, Projects.

The major thrust of the Michigan Institute of Water Research during the 1988 program year involved activities related to its research program, statewide water resources planning activities, use of geographic information systems and the technology transfer program. Water management planning along with surface and groundwater contamination problems are the top priority issues in the state at the present time. Research projects funded by the Institute of Water Research to address these problems and issues included: an interdisciplinary approach to valuation of Michigan's coastal wetlands (02); the hydrogeological and hydrogeochemical characterization and implication for consumptive use of a large glacial-drift aquifer system in southwest Michigan (03); an environmental isotopic approach to establish the susceptibility of buried aquifers to surface derived contaminants (04); the upgrading of microcomputer workstation for the dissemination of groundwater information to local decision makers (33); and the development and implementation of the Institute of Water Research technology transfer program through publication and dissemination of research results, distribution of water related newsletter and information materials, responses to requests for information, coordination of conferences and publication of conference proceedings, and the development of educational audio-visual programs (22). (USGS)
W90-03889

FISCAL YEAR 1989 PROGRAM REPORT (VIRGINIA WATER RESOURCES RESEARCH CENTER).
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
W. R. Walker.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-109497/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G 1596-01, July 1989. 32p, 3 append. USGS Contract no. 14-08-0001-G1596. USGS Project no. G 1596-01.

Descriptors: *Water resources institutes, *Virginia, *Research, *Information transfer, *Training, Education, Projects.

The Virginia Water Resources Research Center's 1987-1992 Five-Year Plan has focused on four major water resources issues confronting Virginia: (1) water resources planning; (2) land use effects on water resources; (3) land application of sewage sludge, and (4) water-related health concerns. During the 1988 federal fiscal year, the Center sponsored seven research projects and 16 students (11 graduate and 5 undergraduate). The research projects emphasized all four of the major water resource issues described in the five-year plan: the effects of agricultural best management practices (BMPs), tillage, and land applied sewage sludge on surface water, groundwater, and nitrate leaching; a comprehensive assessment of the effectiveness and impacts of agricultural BMPs applicable to Virginia; computer modeling of the effects of agricultural practices on groundwater and surface water, including the Chesapeake Bay; comparisons of two U.S. Environmental Protection Agency approved tests (Extraction Procedure Toxicity Test and Toxicity Characteristic Leachate Procedure) for the analysis of trace organic chemicals in sewage sludge; a study on the feasibility of using a modified helium microwave plasma for the determination of non-metal and metal concentrations in drinking water; the economic impacts and managerial implications for Virginia's water supply industry of the 1986 Amendments to the Safe Drinking Water Act; and the potential of natural soil microorganisms to degrade pollutants in the subsoil. During the past year, three conferences--'Pesticides: Risks, Management, and Alternatives'; '1989 Virginia Water Resources Conference (in concert with the Virginia Lake Society, chapter of the North American Lake Management Society)'; and 'Pesticides in Terrestrial and Aquatic Environments' were sponsored by the Center. Proceedings for the one of the two pesticides conferences and three bulletins of Center-sponsoring research were published during the year. More than 26,000 publications were distributed by the Center during the year. In addition to the bulletins and proceedings, noteworthy publications included 'Threats to Virginia's Groundwater'. This book and a companion slide-tape/video are being used in middle and high

schools throughout the state. (Weigmann-VA Tech.)
W90-03897

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

OECD ENVIRONMENTAL DATA: DONNEES OCDE SWR L'ENVIRONMENT, COMPENDIUM 1989.
Organization for Economic Co-Operation and Development, Paris (France).
Organization for Economic Co-Operation and Development, Paris, France. 1989. 326 p. (English and French).

Descriptors: *Europe, *Data collections, *Environmental effects, *Ecological effects, Air pollution, Inland waterways, Marine environment, Forests, Land use, Wildlife, Solid wastes, Radioactivity, Noise.

Environmental information and reporting are important activities of the governments of the Organization for Economic Co-Operation and Development (OECD) member countries. They are a way of responding to public demands for environmental information, they assist in the definition, implementation and evaluation of environmental policies and they help to incorporate environmental concerns in decision making. The Compendium of Environmental Data is a statistical document that includes updated and revised data, and a number of new tables on topics which had not previously been covered. Sections 2 to 11 of the compendium relate to the state of the environment itself (air, inland waters, marine environment, land, forests, wildlife, solid wastes, noise, risks and radioactivity), and sections 12 to 15 relate to activities generating pressures on the environment: energy, transport, industry, and agriculture. The last part includes a section on general data. Information on the responses of economic agents to the pressures on the environment are not included in the 1989 version of the OECD Compendium. (Lantz-PTT)
W90-03742

DRINKING WATER HEALTH ADVISORY: PESTICIDES.
For primary bibliographic entry see Field 5G.
W90-03747

HANDBOOK OF ENVIRONMENTAL FATE AND EXPOSURE DATA FOR ORGANIC CHEMICALS.
Syracuse Research Corp., NY. Center for Chemical Hazard Assessment.
For primary bibliographic entry see Field 5B.
W90-03748

U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PROGRAM FISCAL YEAR 1988.
Geological Survey, Reston, VA.
B. K. Gilbert, and W. B. Mann.
Available from the Books and Open FIle Report Section, USGS, Vol 25425, Denver, CO. 80225. USGS Open-File Report 89-389, 1989. 66p, 2 fig, 12 ref, 2 append.

Descriptors: *State jurisdiction, *Water resources data, *Federal jurisdiction, *Water resources management, *Data acquisition, Water supply, Water quality, Water use, Economic aspects, Agriculture, Groundwater.

The Federal-State Cooperative Program is a partnership between the US Geological Survey and State and local agencies. It provides a balanced approach to the study and resolution of water related problems and to acquiring hydrologic data. The principal program objectives are to: (1) collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources, and (2) appraise the availability and the physical, chemical, and biological characteristics of surface and groundwater through analytical and interpretive investigations. During fiscal year 1988, hydrologic data collection, interpretive investigations, and research were conducted by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in cooperation with more than 1,000 local, State, and regional agencies. In fiscal year 1988, Federal funding of almost $60 million was matched by cooperating agencies, who also provided approximately $6 million unmatched for a total program of about $126 million. This amounted to > 40% of the total funds for Geological Survey water resources activities. The report presents examples of current (1988) investigations. It also lists about 250 water resources investigations related to agricultural activities that the Geological Survey conducted from 1970 to 1988. (Author's abstract)
W90-03814

GEOGRAPHIC INFORMATION SYSTEM/WATERSHED MODEL INTERFACE.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-03826

WATER RESOURCES INVESTIGATIONS IN TENNESSEE: PROGRAMS AND ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY, 1988-89.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-03875

OIL WATER SEPARATORS. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-04477

PLUMBING AND DISTRIBUTION SYSTEMS FOR DRINKING WATER. JANUARY 1970-JANUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W90-04478

SOIL EROSION CONTROL: WATERWAY EMBANKMENTS. NOVEMBER 1986-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 4D.
W90-04479

PLUMBING AND DISTRIBUTION SYSTEMS FOR DRINKING WATER. JANUARY 1977-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W90-04480

EFFLUENT TREATMENT IN THE TEXTILE INDUSTRY: EXCLUDING DYES. JANUARY 1983-JANUARY 1989 (CITATIONS FROM THE WORLD TEXTILE ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-04481

EARTH DAMS: DESIGN, CONSTRUCTION, AND SAFETY. JANUARY 1977-JANUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 8A.
W90-04482

ACTIVATED CARBON: UTILIZATION IN SEWAGE AND INDUSTRIAL WASTE TREATMENT. JANUARY 1987-DECEMBER 1988 (CITATIONS FROM THE NTIS BIBLIOGRAPHIC DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-04483

WATER POLLUTION: PESTICIDES IN AQUATIC ENVIRONMENTS. JANUARY 1970-DECEMBER 1988 (CITATIONS FROM THE POLLUTION ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5C.
W90-04484

ACID PRECIPITATION. SEPTEMBER 1987-DECEMBER 1988 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W90-04485

ACID PRECIPITATION. SEPTEMBER 1986-AUGUST 1987 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W90-04488

GROUND WATER POLLUTION: GENERAL STUDIES. FEBRUARY 1988-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W90-04497

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA): HAZARDOUS WASTES. JANUARY 1970-FEBRUARY 1989 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5G.
W90-04498

WASTEWATER TREATMENT BY SAND FILTRATION. JANUARY 1977-FEBRUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-04499

POLYCHLORINATED BIPHENYLS: OCCURRENCE IN SEDIMENTS AND SOILS. JANUARY 1977-FEBRUARY 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W90-04500

ASBESTOS IN DRINKING WATER. JANUARY 1977-MARCH 1989 (CITATIONS FROM THE SELECTED WATER RESOURCES ABSTRACTS DATABASE).
National Technical Information Service, Spring-

field, VA.
For primary bibliographic entry see Field 5C.
W90-04501

GROUND WATER POLLUTION: GENERAL STUDIES. DECEMBER 1984-JANUARY 1988 (CITATIONS FROM THE NTIS DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 2F.
W90-04502

OIL SPILL REMOVAL: DISPERSANTS, ABSORBANTS, BOOMS, AND SKIMMERS. JANUARY 1978-JANUARY 1989 (CITATIONS FROM THE LIFE SCIENCES COLLECTION DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5G.
W90-04503

EUTROPHICATION: WATER QUALITY AND POLLUTION CONTROL. JANUARY 1970-JANUARY 1989 (CITATIONS FROM THE COMPENDEX DATABASE).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5C.
W90-04504

10D. Specialized Information Center Services

METHOD FOR ESTIMATING THE WATER-TABLE ALTITUDE IN A COASTAL-PLAIN AQUIFER USING A GEOGRAPHIC INFORMATION SYSTEM.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W90-03822

QUALITATIVE AND QUANTITATIVE AQUATIC ALGAL DATA COMPILATION TO DETERMINE MACROTRENDS-III.
Arkansas Univ., Fayetteville. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 2H.
W90-04492

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W90-04469 5D

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W90-04470 5D

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W90-04471 5D

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W90-04488 5B

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Acid Precipitation. September 1987-December 1988 (Citations from the Compendex Database).
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W90-04010 5F

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Activated Carbon: Utilization in Sewage and Industrial Waste Treatment. January 1987-December 1988 (Citations from the NTIS Bibliographic Database).
W90-04483 5D

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W90-04554 7C

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Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

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ACCESSSION NUMBER INDEX

1990 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports

Standard Prices

A01	$8.00
A02	11.00
A03	15.00
A04–A05	17.00
A06–A09	23.00
A10–A13	31.00
A14–A17	39.00
A18–A21	45.00
A22–A25	53.00
A99	*

"N" Codes

N01	$60.00
N02	59.00
N03	20.00

Exception Prices

E01	$10.00
E02	12.00
E03	14.00
E04	16.50
E05	18.50
E06	21.50
E07	24.00
E08	27.00
E09	29.50
E10	32.50
E11	35.00
E12	38.50
E13	41.00
E14	45.00
E15	48.50
E16	53.00
E17	57.50
E18	62.00
E19	69.00
E20	80.00
E99	*

Computer Products

Diskettes

D01	$50
D02	80
D03	130
D04	180
D05	230
D06	280
D07	330
D08	380
D09	430
D10	480
D11	530
D12	580
D13	630
D14	680
D15	730
D16	780
D17	830
D18	880
D19	930
D99	*

Magnetic Tapes

T01	$165
T02	220
T03	340
T04	450
T05	560
T06	670
T07	780
T08	890
T09	1,000
T10	1,110
T11	1,220
T12	1,330
T13	1,440
T14	1,550
T15	1,660
T16	1,770
T17	1,880
T18	1,990
T19	2,100
T99	*

* Contact NTIS for price

Prices effective January 1, 1990

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